

## Table of Contents

	<u>Page</u>
8.0 WATER RESOURCE PROTECTION .....	1
8.1 Introduction .....	1
8.2 Criteria .....	1
8.2.1 General Project Criteria .....	1
8.2.2 Statutes, Regulations and Other Applicable Authorities .....	3
8.2.3 Department of the Army Section 10 and 404 Permit.....	3
8.3 Methodologies .....	4
8.3.1 Water Resource Protection (WRP) Plan .....	4
8.3.2 Baseline Assessment .....	5
8.3.3 Review of TAPS Experience .....	5
8.3.4 WRP Principles.....	5
8.3.5 WRP Methodologies.....	5
8.3.6 WRP Contingency Methodologies.....	6
8.4 Figures and Tables.....	6
8.5 Bibliography .....	7
8.5.1 Project-Specific Information.....	7
8.5.2 Other Project-Location Related and General Water Resources Information .....	10
8.6 Attachments.....	26

## **8.0 WATER RESOURCE PROTECTION**

### **8.1 INTRODUCTION**

The Project will develop, establish and maintain a Water Resource Protection (WRP) Program for managing the protection of water resources along the Alaska segment of the Alaska Natural Gas Transportation System (ANGTS). The primary objective of the WRP Program is to avoid impacts to water resources through prevention measures taken during all phases of the Project including planning and design, construction, rehabilitation, operation and maintenance, and decommissioning.

The Project will prepare a WRP Plan that will serve as a guide to the implementation of the WRP Program through coordination with the Technical and other Environmental Protection Programs through all phases of the Project.

The Project pipeline route will cross 24 major rivers, dozens of other streams, and nearly half of the pipeline route extends across various types of wetlands. The route also crosses numerous small drainages that are ephemeral and may flow only during breakup or during heavy rains. These watercourses drain expanses of tundra plains, mountains, forests and wetlands in northern and interior Alaska.

The Project recognizes the sensitive nature of the water resources along the pipeline route, including groundwater, wetlands, streams, and rivers, and continues to identify ways to avoid and minimize potential impacts to these important resources. These measures have and will continue to involve all aspects of the Project, including route planning and design, construction, operation and maintenance.

### **8.2 CRITERIA**

These criteria also constitute the preliminary WRP Principles that will be used to guide the Project design and development of the Environmental Protection Programs.

#### **8.2.1 General Project Criteria**

##### **8.2.1.1 Surface Water**

Where feasible, the Project will be designed to:

- Reduce the number of river and stream crossings.
- Avoid the use of structures or situations that promote erosion and sedimentation, restriction of natural meander, and alteration of stream flow.
- Reduce the potential for pipeline-induced thermal effects on surface water temperatures in areas that could affect fish and other aquatic life.

- Be capable of withstanding adverse conditions such as runoff, stream and floodplain erosion, meander cutoffs, lateral migration, ice jams, and icing conditions that are characteristic for each hydrologic region encompassed by the pipeline route.
- Project construction procedures will be managed and conducted, where feasible, to:
- Avoid unauthorized discharges of material of any kind into rivers, streams and other water bodies.
- Prevent conditions leading to erosion, run-on and runoff, sedimentation on vegetation, or deposition into streams and rivers or other water bodies.
- Reduce potential impacts to streambeds by scheduling construction in streams and rivers during low-flow conditions.
- Evaluate the feasibility for utilizing alternative crossing techniques such as directional drilling beneath the streambed.

#### 8.2.1.2 Groundwater

- The development of the Project design will take into consideration and evaluate the opportunities to:
- Reduce the potential for creating adverse groundwater conditions such as aufeis development resulting from groundwater diversion and thermal effects.
- Reduce the potential for groundwater diversion and thermal effects on springs or discharge to fish spawning and rearing areas in streams and rivers.

Groundwater encountered during trenching or other Project activities will be discharged in a manner that does not impact surface water in accordance with regulatory requirements.

If groundwater that is encountered by the Project activities is found to be contaminated with petroleum or other hazardous substances it will be handled in accordance with regulatory requirements in consultation with the Alaska Department of Environmental Conservation (see ENVIS09 Contaminated Sites Summary for information).

#### 8.2.1.3 Wetlands

Where feasible, the Project will:

- Reduce the siting and placement of permanent facilities or structures in wetlands.
- Reduce the area of wetlands affected by construction.
- Utilize winter construction to take advantage of frozen soil conditions, dormant vegetation, and low water levels.
- Reduce the potential for major alteration of drainage in wetlands.
- Avoid situations that could alter surface water temperatures in areas that could affect fish and other aquatic life residing in wetlands.

- Make every effort to avoid blocking natural drainage during system operation.

The report of the Wetlands Task Force of the Alaskan Executive Coordinating Committee (February 1, 1980) divides wetlands into three categories with respect to the Department of the Army, Corps of Engineers permits concerning the placement of fill or excavated material in wetlands. The categories were based on vegetation and wetland mapping of the route<sup>1</sup>. The boundary of the wetlands and their category assignments are depicted on pipeline alignment sheets. The wetland categories are:

“A” wetlands include those to be entirely avoided by construction.

“B” wetlands include those requiring a site-specific Section 404 permit.

“C” wetlands include those requiring a general permit.

### 8.2.2 Statutes, Regulations and Other Applicable Authorities

- 18 AAC 70, Alaska Water Quality Standards
- 18 AAC 72, Alaska Wastewater Disposal Regulations
- Alaska Statute 16.05.840 (Fishway Act)
- Alaska Statute 16.05.870 (Anadromous Fish Act)
- 33 CFR 323, Permits For Discharges of Dredged or Fill Material into Waters of the United States.
- 40 CFR 230 – 230, U.S. Environmental Protection Agency Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material
- 18 CFR 380.12, “FERC’s Environmental Reports for Natural Gas Act Applications,” and FERC environmental policy guidelines thereunder;
- Federal Right-of-Way Grant for the Alaska Natural Gas Transportation System Alaska Segment, Serial No. F-24538 (December 1, 1980), as such may be updated and/or amended from time to time.
- Federal Energy Regulatory Commission conditional certificate of public convenience and necessity, issued on December 16, 1977, as such is finalized.

### 8.2.3 Department of the Army Section 10 and 404 Permit

- Permit 071-OYD-2-830282 “Sagavanirktok River 120”, January 4, 1984 (as modified September 9, 1987). This permit expires September 7, 2007.
- Special Conditions (28) establish restrictions on the methods, locations, and schedule of construction to protect surface waters and wetlands.

---

<sup>1</sup> Markon, C.J. 1980. Terrestrial and aquatic habitat mapping along the Alaska Natural Gas Pipeline System; U.S. Fish and Wildlife Service Special Study Report, December 1980, 67pp.

- Permit is for “C” wetlands only. Work in “B” wetlands requires a site-specific individual permit. (No activity allowed in “A” wetlands).

### 8.3 METHODOLOGIES

The methodologies for implementing the WRP Program include:

- WRP Program Plan will be developed.
- Baseline assessment of water resources along the pipeline corridor.
- Review of water resource effects and mitigation techniques used during the construction and operation of the Trans-Alaska Pipeline System (TAPS).
- Development and integration of WRP principles into the planning, site selection, design, and construction of the pipeline and related facilities. This will involve close coordination with other technical and environmental protection programs, in particular:
  - Material Sites (TIS05)
  - Disposal Sites (TIS06)
  - Access Roads (TIS07)
  - Storage Yards (TIS08)
  - Workpad Design (TIS09)
  - Bridges (TIS14)
  - Stream, River and Wetland Crossings (TIS16)
  - Drainage and Erosion Control (TIS11)
  - Clearing (TIS10)
  - Rehabilitation (TIS12)
  - Fish and Wildlife Protection (ENVIS07)
  - Waste Management (ENVIS04)
  - Oil & Hazardous Substances Mngt. (ENVIS05)
  - Contaminated Sites Management (ENVIS09)

#### 8.3.1 Water Resource Protection (WRP) Plan

The WRP Plan will be developed to outline the structure and function of the WRP program.

The WRP Plan will provide a roadmap for integrating the Environmental Protection Programs related to water resources with all phases of the Project including design, construction, operation and maintenance.

### 8.3.2 Baseline Assessment

Baseline assessments of streams, rivers, wetlands and drainage along the ANGTS pipeline route were conducted in the late 1970's and early 1980's (see Bibliography in Section 8.5). These included hydrology, water quality and aquatic biology measurements taken in streams and rivers crossed by the pipeline ROW. These data provide a valid and relatively complete assessment of the baseline conditions that existed at that time.

A review of the existing Project water resources data will be performed and an evaluation of the need for additional baseline data will be made.

An important part of the updating the Baseline Assessment will include a review of contemporary scientific and engineering literature, reports and other sources of data or information that are relevant to the protection of water resources during the life of the Project. A preliminary Bibliography is provided that consists of a compilation of lists from recent reports and online literature searches. This Bibliography will be further updated during the development of the WRP Program.

Another important component of the WRP Baseline Assessment is a review of climatic and river discharge records for sites along the Project route. This will aid in the design of the mitigation measures for reducing impacts to water resources. A preliminary set of these records selected from representative and available data are presented in Attachment A.

### 8.3.3 Review of TAPS Experience

The experience of water resource management involved with the construction and operation of the TAPS will be reviewed for potentially useful water resource protection measures and help predict locations where potential management problems may occur. The results of this review will be compiled into a formal review document titled "Review of Water Resource Impacts and Mitigation Techniques Associated with TAPS Construction and Operation: Applications for Planning and Design of the Alaska Segment of the ANGTS Project".

### 8.3.4 WRP Principles

A set of WRP Principles will be developed from the environmental protection programs that relate to water resources. The WRP Principles will be used to guide coordination with the technical programs during the project design phase and in the development of environmental protection measures that involve water resources.

### 8.3.5 WRP Methodologies

A primary role of the WRP Program will be the identification, evaluation, and development of specific methodologies for protection of water resources. The WRP Program will coordinate with the technical design programs in establishing the site-specific methodologies for WRP implementation. The methodologies will be incorporated into the Project design and implemented through the WRP Program.

Specific methodologies for WRP will be identified from a variety of sources, including:

- Coordination with the Alaska Department of Fish and Game (ADFG) and Department of Environmental Conservation (ADEC), as well as from published guidance from these and other resource agencies.
- Application of Project data and information developed during the previous federal filings.
- Historical data from the TAPS construction experience.
- Contemporary research and development obtained from published reports, literature and consultation with regional or local experts.

For example, the Alaska Department of Fish and Game has developed and published specific guidance for the design of culverts for fish passage, streambank revegetation, stream fluming techniques and temporary stream diversion techniques. These guidance documents will be used to frame the development of specific WRP methodologies through coordination with ADFG habitat biologists.

#### 8.3.6 WRP Contingency Methodologies

In addition to the methodologies implemented for routine compliance with the WRP Criteria and Principles, methodologies for WRP Contingency Events such as extreme precipitation, erosion, slope failures, and others will be identified, evaluated, and developed.

#### 8.4 FIGURES AND TABLES

(None)

## 8.5 BIBLIOGRAPHY

This bibliography is presented separately for Project-specific information and other information that is Project location-specific or general Alaska information taken from recent reports and from literature searches. This bibliography will be updated during the development of the WRP Program.

### 8.5.1 Project-Specific Information

Anonymous. 1978 (Aug). Field Validation of Fish Streams Between the Canadian Border and Delta Junction for Northwest Alaskan Pipeline Company. Dames & Moore. Anchorage, Alaska.<sup>2</sup>

Anonymous. 1979 (Mar). Fish Streams Crossed by the Proposed Northwest Alaskan Pipeline Company Gas Pipeline, Delta to the Canadian Border. Interagency Fish and Wildlife Task Force.

Anonymous. 1979 (Oct). Fish Stream Identification Forms. Alaska Department of Fish & Game. Fairbanks, Alaska.

Anonymous. 1980 (Jan). Fish Resource Areas of the Northwest Alaskan Gas Pipeline Corridor – Phase I: Status and Packaging Study. Alaska Department of Fish & Game. Anchorage, Alaska.

Anonymous. 1980 (Jul). Sensitive Wildlife Areas of the Northwest Alaskan Gas Pipeline Corridor. Alaska Department of Fish & Game. Anchorage, Alaska.

Anonymous. 1980 (Mar). Sensitive Wildlife Areas of the Northwest Alaskan Gas Pipeline Corridor. Attachments. Alaska Department of Fish & Game. Anchorage, Alaska.

Anonymous. 1981. Fish Stream Identification. DFG Pipeline Surveillance. Alaska Department of Fish & Game. Anchorage, Alaska.

Anonymous. 1981. Preliminary List of Fish Streams Impacted by Northwest Alaskan Pipeline Company Proposed Material Sites and Access Roads. Alaska Department of Fish & Game. Anchorage, Alaska.

Anonymous. No Date. Fish Over-Wintering Areas in the Utility Corridor – Washington Creek to Sagwon Bluffs. Source Unknown.

Anonymous. No Date. Terrestrial and Aquatic Habitat Evaluation of the Alaska Highway Pipeline Corridor. Alaska Department of Fish & Game. Anchorage, Alaska.

Bio/West, Inc. 1976 (Oct). A List of Fish Streams Crossed by The Proposed Alcan Gas Pipeline in Alaska, Including Fish Species Present and Periods of Sensitivity. Bio/West, Inc. Houston, Texas.<sup>2</sup>

Bio/West, Inc. 1976. Stream Survey Forms. Bio/West, Inc. Houston, Texas.<sup>2</sup>

---

<sup>2</sup> This document is stamped, marked or otherwise identified as confidential and/or proprietary or otherwise protected. The ANNGTC continues to claim confidential treatment for this document, and it should be withheld from disclosure.

Chihuly, M., D. Ward, P. Craig and R. McMillan. 1979 (Sep). Winter Fisheries Survey and Provisional List of Waterbodies Along the Alaskan Gas Pipeline Route (Prudhoe Bay to the Yukon Territory) Proposed by Northwest Alaskan Pipeline Company. LGL Ecological Research Associates, Inc. Fairbanks, Alaska. 274 pp.<sup>2</sup>

Chihuly, M., D. Ward, P. Craig, R. McMillan and R. Morrison. 1980 (Jan). Spring Fisheries Survey and Provisional List of Waterbodies Along the Alaskan Gas Pipeline Route (Prudhoe Bay to the Yukon Territory) Proposed by Northwest Alaskan Pipeline Company. LGL Ecological Research Associates, Inc. Fairbanks, Alaska. 211 pp.<sup>2</sup>

Chihuly, M., D. Ward, P. Craig, R. McMillan, R. Morrison, T. Olson and A. Sekerak. 1980 (Mar). Fall Fisheries Survey and Provisional List of Waterbodies Along the Alaskan Gas Pipeline Route (Prudhoe Bay to the Yukon Territory) Proposed by Northwest Alaskan Pipeline Company. LGL Ecological Research Associates, Inc. Fairbanks, Alaska. 180 pp.<sup>2</sup>

Chihuly, M., R. McMillan, R. Morrison, T. Olson and A. Sekerak. 1980 (Mar). Early Winter Fisheries Survey and Provisional List of Waterbodies Along the Alaskan Gas Pipeline Route (Prudhoe Bay to the Yukon Territory) Proposed by Northwest Alaskan Pipeline Company. LGL Ecological Research Associates, Inc. Fairbanks, Alaska. 180 pp.<sup>2</sup>

Elliott, George V. 1980 (Jun). First Interim Report on the Evaluation of Stream Crossings and Effects of Channel Modifications on Fisher Resources Along the Route of the Trans-Alaska Pipeline. U.S. Fish And Wildlife Service. Anchorage, Alaska.

Evans, Willis A. and Beryl Johnston. 1972 (Jun). Revised 1980 (June). Fish Migration and Fish Passage: A Practical Guide to Solving Fish Passage Problems. Forest Service, U.S.D.A. Washington, DC.

Executive Coordinating Committee. 1978 (May). Proposed Project Related Fish and Wildlife Investigations for the Northwest Alaskan Natural Gas Pipeline. Bureau of Land Management, United States Department of the Interior. Anchorage, Alaska.

Gustafson, Jack. 1977. An Evaluation of Low Water Crossings at Fish Streams Along the Trans-Alaska Pipeline System. Special Report Number 16. U.S. Department of the Interior, Alaska Pipeline Office and the State of Alaska, Pipeline Coordinator's Office.

Holden, PB. 1976 (June). Fisheries Survey of Proposed Compressor Sites for Alcan Pipeline Project: Report to GIEC Environmental Department. BioTect? Inc., Logan, Utah.<sup>2</sup>

Hynig, Jack M. 1976 (Dec). Salmon Surveys of the Upper Tanana River, 1976. NERKA, Incorporated. Fairbanks, Alaska.<sup>2</sup>

Kessel, Brina, Stephen M. Murphy and Leonard J. Vining. 1980 (May). Draft: Waterbirds and Wetlands Chisana-Upper Tanana Rivers, Alaska, 1979 (with emphasis on the Scottie-Desper Creek Wetlands). University of Alaska Museum. Fairbanks, Alaska.

Kessel, Brina. 1979 (Dec). Migration of Sandhill Cranes, Upper Tanana River Valley, Alaska. University of Alaska. Fairbanks, Alaska.

Markon, Carl J. 1980 (Dec). Terrestrial and Aquatic Habitat mapping Along the Alaska Natural Gas Pipeline System. U.S. Fish And Wildlife Service. Anchorage, Alaska.

Morsell, J., J. Houghton, M. Bell, R. Costello. 1981 (Mar). Fish Protection Strategies for the Design and Construction of the Alaska Segment of the Alaska Natural Gas Transportation System. Dames & Moore. Anchorage, Alaska.<sup>2</sup>

NWA Environmental Group Fisheries Data Spread No. 3, 041-066. Fluor Engineers and Constructors, Inc/NWA Environmental Group, 1980.<sup>2</sup>

NWA Environmental Group Fisheries Data Spread No. 6, 111-131. Fluor Engineers and Constructors, Inc/NWA Environmental Group, 1980.<sup>2</sup>

Ott, A.G. and K.E. Tarbox. 1977 (Aug). “Instream Flow” Applicability of Existing Methodologies for Alaskan Waters. Final Report. Woodward-Clyde Consultants. Anchorage, Alaska.

Platts, William S. 1980 (Jan-Feb). A Plea For Fishery Habitat Classification. Article in “Fisheries” Magazine.

Robinson, Ross. 1981 (Dec). Access Roads that are Crossed by Streams. Source Unknown. Fairbanks, Alaska.<sup>2</sup>

Sevitz, William S., Robert Blanscett, James Glaspell and James P. Webb. 1980 (Apr). The Alaska Information Management System (AIMS) Environmental master Guide (EMG) Task Force Report. Fluor Engineers & Constructors, Inc. Irvine, California.<sup>2</sup>

Valdez, Richard A. 1976 (Aug). Fisheries Survey of Tanana River Tributaries Along the Alcan Gas Pipeline Route. Bio/West, Inc. Logan, Utah.<sup>2</sup>

### 8.5.2 Other Project-Location Related and General Water Resources Information

Adamus, P. R. 1987. Wetland evaluation technique (WET). Volume II Methodology. US Dept. of the Army, Waterways Experiment Station, Corps of Engineers, Vicksburg, Mississippi.

Aiblin, A.E., K.J. Nadelhoffer, G.R. Shaver, J.A. Laundre and A.J. McKerrow. 1991. Biogeochemical diversity along riverside toposequence in arctic Alaska. *Ecological Monographs* 61(4): 415-35.

Alaska Department of Environmental Conservation. 1999. Tundra treatment guidelines: a manual for treating oil and hazardous substance spills to tundra. Alaska Department of Environmental Conservation: Division of Spill Prevention and Response and Prevention and Emergency Response Program.

Alaska Department of Highways, 1972. Designing the Yukon River Bridge. Alaska Department of Highways, Bridge Design Section. 47 pp.

Alter, A., 1969. Water supply in cold regions. U. S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, Cold Regions Science and Engineering Monograph 3, Section C5a. 91 pp.

Anderson, G. S., 1970. Hydrologic reconnaissance of the Tanana Basin, Central Alaska. U. S. Geological Survey. Hydrologic Investigations HA-319. 4 sheets.

Balding, G. O., 1976. Water availability, quality, and use in Alaska. U. S. Geological Survey Open-File Report 76-513. 236 pp.

Batten, Alan R. and D.F. Murray. 1982. A literature survey on the wetland vegetation of Alaska: U.S. Army Engineer Waterways Experiment Station Technical Report Y-82-2, 222p.

Berg, R. and N. Smith, 1976. Observations along the pipeline haul road between Livengood and the Yukon River. U. S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, Special Report 76-11. 73 pp.

Berwick, J. M. Childers, and M. A. Kuentzel, 1964. Magnitude and frequency of floods in Alaska, South of the Yukon River. U. S. Geological Survey Circular 493. 15 pp.

Bigelow, B. B., R. D. Lamke, P. J. Still, J. L. VanMaanen, and J. E. Vaill, 1985. Water resources data for Alaska-Water Year 1984. U. S. Geological Survey, Water-Data Report AK-84-1. 350 pp.

Billings, W.D. 1973. Arctic and alpine vegetation: similarities, differences, and susceptibility to disturbance. *Bio Science* 23(12):697-704.

Bishop, S.C. and F.S. Chapin, III, 1989b. Patterns of natural revegetation on abandoned gravel pads in arctic Alaska. *J. Appl. Ecol.* 26:1073-1081.

Bishop, S.C., J.G. Kidd, T.C. Cater, L.J. Rossow and M.T. Jorgenson. 1998. Land rehabilitation studies in the Kuparuk Oilfield, Alaska, 1997. Twelfth Annual Report. Prepared for ARCO, Alaska, Inc. April.

BP Exploration (Alaska), Inc. 1994. 1993 X-Pad restoration progress report and cooperative reclamation plan. September 1, 1993 to August 31, 1996. Environmental and Regulatory Affairs, Anchorage, Alaska.

Brabets, T.P., 1996, Evaluation of the streamflow-gauging network of Alaska in providing regional streamflow information: U.S. Geological Survey Water-Resources Investigations Report 96-4001, 73 p. [Abstract]

Brabets, T.P., 1997, Regional streamflow information in Alaska--An investment in the future: U.S. Geological Survey Open-File Report 96-630, 2 p.

Brabets, T.P., 2001, Hydrologic data and a proposed water-quality monitoring network for the Kobuk River basin, Gates of the Arctic National Park and Preserve, and Kobuk Valley National Park, Alaska: U.S. Geological Survey Open-File Report 01-4141, 23 p. [Abstract and link to full report]

Brabets, T.P., Wang, Bronwen, and Meade, Robert H., 2000, Environmental and hydrologic overview of the Yukon River Basin, Alaska and Canada: U.S. Geological Survey Water-Resources Investigations Report 99-4204, 106 p. [Abstract and link to full report]

Brewer, M.C., 1958, some results of geothermal investigations of permafrost in northern Alaska: Transactions of the American Geophysical Union, v. 39, no. 1, pg 19-25.

Brewer, M.C., 1958, the thermal regime of an Arctic lake: Transactions of the American Geophysical Union, v. 39, no. 2, pg. 278-284.

Brice, J., 1971. Measurement of lateral erosion at proposed river crossing sites of the Alaska Pipeline. U. S. Geological Survey. 39 pp.

Brinson, M. M. 1993. A hydrogeomorphic classification for wetlands. U.S. Army Corps of Engineers, Wetlands Research Program. Technical Report WRP-DE-4. Washington DC. August.

Brooks, J.W., J.C. Bartonek, D.R. Klein, D.L. Spencer and A.S. Thayer. 1971. Environmental influences of oil and gas development in the Arctic Slope and Beaufort Sea. *U.S. Fish Wildl. Serv., Resour. Publ.* 96:1-24.

Brown, A.L. and J.D. McKendrick. 1987. Joint industry/agency/university revegetation feasibility project. Paper presented at Fifth Symposium on Coastal and Ocean Management (Coastal Zone '87), Seattle, WA. May 26-29.

Brown, J. and R. L. Berg, eds., 1980. Environmental engineering and ecological baseline investigations along the Yukon River-Prudhoe Bay Haul Road. U. S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, Report 80-19. 187 pp.

Brown, J., N. Liston, D. Murphy and J. Watts. 1983. U.S. tundra biome publication list. U.S. Tundra Biome – International Biological Program. Final report to Division of Polar Programs, National Science Foundation.

Brown, Jerry, R.K. Haugen, and S. Parrish. 1975. Selected climatic and soil thermal characteristics of the Prudhoe Bay region. Ecological Investigations of the Tundra Biome in the Prudhoe Bay Region, Alaska, Jerry Brown (ed.), October 1975, pp. 3-11.

Brown, R.W., R.S. Johnston, and K. Van Cleve. 1978. Rehabilitation Problems in Alpine and Arctic Regions. Chapter 3, Pages 23-45 in *Reclamation of Drastically Disturbed Lands*. ASA-CSSA-SSSA, Madison WI.

Brunett, J.O., 1986, Ground-water levels in Alaska, water year 1983: U.S. Geological Survey Open-File Report 86-56, 229 p.

Buchkina, N. 1998. Effects of native cover plants on mechanical stability of tundra soils. *Journal of Soil and Water Conservation*. July.

Burrows, R. L., 1980. Cross-section, velocity, and bed load data at two erosion sites on the Tanana River near Fairbanks, Alaska, 1979. U. S. Geological Survey Open File Report 80-699. 32pp.

Burrows, R.L., Langley D.E., and Evetts, D.M., 2000, Preliminary Hydraulic Analysis and Implications for Restoration of Noyes Slough, Fairbanks, Alaska: U.S. Geological Survey Water-Resources Investigations Report 00-4227, 32 p. [Abstract and link to full report]

Cargill, S.M. 1988. Establishment of native plants on disturbed sites in arctic Alaska: a thesis. Presented to the faculty of the University of Alaska, Fairbanks, Alaska.

Cargill, S.M. and F.S. Chapin III. 1986. Establishment of native plants on disturbed sites in arctic Alaska. P.J. Webber (ed.): Restoration and Vegetation Succession in Circumpolar Lands. Proceedings of the 7th Conference Comite Arctique Int., 7-13 September 1986, Reykjavik, Iceland. (Cited in Jorgenson 1988).

Cargill, S.M. and F.S. Chapin III. 1987. Application of successional theory to tundra restoration: a review. *Arctic and Alpine Research* 19(4):366-372.

Carlson, R. F. and P. Fox, 1974. Flood frequency estimation in northern sparse data regions. University of Alaska, Institute of Water Resources, Report No. IWR-55. 15 pp.

Carlson, R. F., 1972. Development of a conceptual hydrologic model for a sub-Arctic watershed. University of Alaska, Institute of Water Resources, Report No. IWR-28. 58 pp.

Carlson, R. F., D. L. Kane, and G. Wendler, 1974. A study of the breakup characteristics of the Chena River Basin using ERTS imagery. University of Alaska, Institute of Water Resources, Report No. IWR-60. 32 pp.

Cater, T.C. and M.T. Jorgenson. 1994. Remediation of gravel and tundra at the SWPT pad, Kuparuk Oilfield, Alaska, 1993, Final Report. Alaska Biological Research, Inc. report to ARCO Alaska, Inc. March.

Cater, T.C. and M.T. Jorgenson. 1996a. Land rehabilitation studies in the Kuparuk Oilfield, Alaska, 1995. Alaska Biological Research, Inc. report to ARCO Alaska, Inc. and Kuparuk River Unit, December.

Cater, T.C. and M.T. Jorgenson. 1999. Assessing damage from hydrocarbons and cleanup operations after crude oil spills in arctic Alaska. Alaska Biological Research, Inc. report to ARCO Alaska, Inc. February.

Cederstrom, D.J., 1952, Summary of ground-water development in Alaska: U.S. Geological Survey Circular 169, 37 p.

Chapin, F.S. and G.R. Shaver. 1985. Individualistic growth response of tundra plant species to environmental manipulations in the field. *Ecology* 66(2):564-576.

Chester, A.L. and G.R. Shaver. 1982. Seedling dynamics of some cotton grass tussock tundra species during the natural revegetation of small disturbed areas. *Holarctic Ecology* 5:207-11.

Childers, J. M. 1970. A proposed streamflow-data program in Alaska. U. S. Geological Survey, Open-File Report. 55 pp.

- Childers, J. M. 1970. Flood frequency in Alaska. U. S. Geological Survey, Open-File Report. 30pp.
- Childers, J. M. 1972. Flood surveys along proposed TAPS route, Alaska, July 1971. U. S. Geological Survey, Basic-Data Report. 16 pp.
- Childers, J. M. 1972. Channel erosion surveys along proposed TAPS route, Alaska, July 1971. U.S. Geological Survey, Basic-Data Report. 79 pp.
- Childers, J. M. 1974. Flood surveys along TAPS route, Alaska. U. S. Geological Survey, Basic-Data Report. 16 pp.
- Childers, J. M. 1975. Channel erosion surveys along southern segment of the TAPS route, Alaska, 1972 and 1973. U.S. Geological Survey Open-File Report. 57 pp.
- Childers, J. M. C. E. Sloan, and J. P. Meckel, 1973. Hydrologic reconnaissance of streams and springs in the eastern Brooks Range, Alaska, 1972. U. S. Geological Survey Basic-Data Report. 25 pp.
- Childers, J. M., C. E. Sloan, J. P. Meckel, and J. W. Nauman, 1977. Hydrologic reconnaissance of the eastern North Slope, Alaska, 1975. U. S. Geological Survey Open-File Report 77-492. 65 pp.
- Childers, J. M., J. W. Nauman, D. R. Kernodle, P. F. Doyle, 1977. Water resources along the TAPS route, Alaska, 1970-74. U. S. Geological Survey, Open-File Report. 136 pp.
- Childers, J.M. 1978. River floods in northern Alaska, in Volume 1, Proceedings, Conference on Applied Techniques for Cold Environments, Cold Regions Specialty Conference, Anchorage, May 17-19, 1978: American Society of Civil Engineers, p. 1-12.
- Childers, J.M. and Jones, S.H., 1975. Channel erosion surveys along TAPS route, Alaska, 1974: U.S. Geological Survey Open-File Report, 145 p.
- Childers, J.M., 1970. A proposed streamflow-data program for Alaska: U.S. Geological Survey Open-File Report, 55 p.
- Childers, J.M., and Lamke, R.D., 1973. Flood survey at proposed TAPS crossings of Yukon River near Stevens Village, Alaska: U.S. Geological Survey Open-File Report, 12 p.
- Childers, J.M., Meckel, J.P., and Anderson, G.S., 1972. Floods of August 1967 in East-Central Alaska (With a section on weather features contributing to the floods, by E.D. Diemer): U.S. Geological Survey Water-Supply Paper 1880-A, p. A1-A77.
- Childers, J.M., Nauman, J.W., Kernodle, D.R, and Doyle, P.F., 1978. Water resources along the TAPS route, Alaska, 1970-74: U.S. Geological Survey Open-File Report 78-137, 136 p.
- Childers, J.M., Sloan, C.E., and Meckel, J.P., 1973. Hydrologic reconnaissance of streams and springs in eastern Brooks Range, Alaska, July 1972: U.S. Geological Survey Open-File Report, 25 p.
- Childers, J.M., Sloan, C.E., Meckel, J.P., and Nauman, J.W., 1977. Hydrologic reconnaissance of the eastern North Slope, Alaska, 1975: U.S. Geological Survey Open-File Report 77-492, 65 p.
- Cowan J.R, 1995. Overview of environmental and hydrogeologic conditions at Bettles Field, Alaska: U.S. Geological Survey Open-File Report 95-343, 10 p.

- Cowan, J.R., 1995. Overview of environmental and hydrogeologic conditions at Chandalar Lake, Alaska: U.S. Geological Survey Open-File Report 95-348, 9 p.
- Cowardin, L.M., V. Carter, F.C. Golet and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. Office of Biological Services, U.S. Fish and Wildlife Service. Washington, D.C. December. [FWS/OBS-79/31].
- Dames and Moore. 1999. Seismic/geologic/geotechnical assessments of LNGP sites: Port Valdez and Cook Inlet, Alaska. Final report for Alaska North Slope LNG Project, Anchorage, Alaska.
- Dearborn, L.L., 1981, Potential and developed water-supply sources in Alaska: Alaska Geological Society Journal, v. 1, p. 1-11.
- DenBeste, J. and P. McCart. 1984. Catalog of streams associated with the Trans-Alaska Pipeline System in the northern district. Prepared for Alyeska Pipeline Service by Aquatic Environments Inc.
- Densmore, R.V., B.J. Neiland, J.C. Zasada and M.A. Masters. 1987. Planting willow for moose habitat restoration on the North Slope of Alaska, U.S.A. *Arctic and Alpine Research* 19(4):537-543.
- Dorava, J.M., and Alcorn M.G., 1995, Overview of environmental and hydrogeologic conditions at Deadhorse, Alaska: U.S. Geological Survey Open-File Report 95-437, 11 p.
- Dorava, J.M., and Hall, J.D., 1995, Overview of environmental and hydrogeologic conditions at Farewell, Alaska: U.S. Geological Survey Open-File Report 95-175, 9 p.
- Doyle, P. F. and J. M. Childers, 1975. Channel erosion surveys along TAPS route, Alaska, 1975. U. S. Geological Survey, Open-File Report. 95 pp.
- Doyle, P. F. and J. M. Childers, 1976. Channel erosion surveys along TAPS route, Alaska, 1976. U.S. Geological Survey, Open-File Report 77-170. 90 pp.
- Dunne, K.P., A.M. Rodrigo and E. Samanns. 1998. Engineering specification guidelines for wetland plant establishment and subgrade preparation. Technical report WRP-RE-19, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.
- Ebersole, J.J. 1987. Short-term vegetation recovery at an Alaskan Arctic Coastal Plain site. *Arctic and Alpine Research* 19(4):442-450.
- Ebersole, J.J. and P.J. Webber. 1983. Biological decomposition and plant succession following disturbance on the Arctic Coastal Plain, Alaska. In Proceedings, Permafrost Fourth International Conference July 17-22, 1983, Fairbanks, AK. pp. 266-271.
- Emers, M. and J.C. Jorgenson. 1995. Effects of winter seismic exploration on tundra vegetation and the soil thermal regime in the Arctic National Wildlife Refuge, Alaska. *Disturbance and Recovery in Arctic Lands*, R.M.M. Crawford (ed.), 1997, Netherlands. pp. 443-454.
- Emmett, W. W. R. L. Burrows, and B. Parks, 1978. Sediment transport in the Tanana River in the vicinity of Fairbanks, Alaska, 1977. U.S. Geological Survey Open File Report 78-290. 28pp.
- Emmett, W.W., 1972, the hydraulic geometry of some Alaskan streams south of the Yukon River: U.S. Geological Survey Open-File Report, 102 p.
- Emmett, W.W., Burrows, R.L., and Chacho, E.F., Jr., 1996, Coarse-particle transport in a gravel-bed river: *International Journal of Sediment Research*, v. 11, no. 2, pg. 8-21. (Toklat River)

- Federal Energy Regulatory Commission. 1994. Upland erosion control, revegetation, and maintenance plan. Washington, DC. December.
- Federal Energy Regulatory Commission. 1994. Wetland and waterbody construction and mitigation procedures. Washington, DC. December.
- Felix N.A. and M.K. Raynolds. 1989. The effects of winter seismic trails on tundra vegetation in northeastern Alaska, U.S.A. *Arctic and Alpine Research* 21(2):188-202.
- Felix, N.A. and M.T. Jorgenson. 1985. Effects of winter seismic exploration on the coastal plain of the Arctic National Wildlife Refuge, Alaska, 1984. U.S. Fish Wildl. Serv., ANWR Prog. Rep. FY 85-1.
- Felix, N.A., M.K. Raynolds, J.C. Jorgenson and K.E. DuBois. 1992. Resistance and resilience of tundra plant communities to disturbance by winter seismic vehicles. *Arctic and Alpine Research* 24(1):69-77.
- Feulner, A.J., 1964, Galleries and their use for development of shallow ground-water supplies, with special reference to Alaska: U.S. Geological Survey Water-Supply Paper 1809-E, p. E1-E16.
- Feulner, A.J., Childers, J.M., and Norman, V.W., 1971, Water resources of Alaska: U.S. Geological Survey Open-File Report, 60 p.
- Gallant, A. L., E. F. Binnian, J. M. Omernik, and M. B. Shasby, 1995. Ecoregions of Alaska. U.S. Geological Survey, Professional Paper 1567. 73 pp.
- Gallant, A.L., E.F. Binnian, J.M. Omernik and M.B. Shasby. 1995. Ecoregions of Alaska. U.S. Geological Survey Professional Paper 1567.
- Gartner, B.L., F.S. Chapin III and G.R. Shaver. 1983. Demographic patterns of seedling establishment and growth of native graminoids in an Alaskan tundra disturbance. *Journal of Applied Ecology* 20:965-980.
- George, T.H. 1985. Wetlands mapping in interior Alaska: analysis of summer and winter Landsat data. Northern Remote Sensing Laboratory, Geophysical Institute, University of Alaska, Fairbanks, Alaska. 38 pp.
- Glass, R.L., 1996, Alaska wetland resources, in U.S. Geological Survey National water summary on wetland resources: U.S. Geological Survey Water-Supply Paper 2435, p. 107-114.
- Glass, Roy L. 1996. State summary of wetland resources: Alaska. *In: National Water Summary—Wetland Resources*. U.S. Geological Survey Water Supply Paper 2425, pp. 107 – 114.
- Glude, W.J., and Sloan, C.E., 1980, Reconnaissance snow survey of the National Petroleum Reserve in Alaska, April-May 1979: U.S. Geological Survey Water-Resources Investigations 80-49, 13 p.
- Hall, Jonathan V. et. al. 1997. Alaska wetlands and hydrography: Final report of the Alaska wetlands GATF project. Prepared for Government Applications Task Force (GATF), Environmental Program, Central Intelligence Agency (CIA), and Civil Applications Committee (CAC).

- Hall, Jonathan V., W.E. Frayer and B.O. Wilen. 1994. Status of Alaska wetlands. U.S. Fish Wildl. Serv. 33 pp.
- Harrold, P. E. and R. L. Burrows, 1983. Sediment transport in the Tanana River near Fairbanks, Alaska, 1982. U.S. Geological Survey, Water-Resources Investigations Report 83-4213. 53 pp.
- Heglund, Patricia J. A. 1992. Patterns of wetland use among aquatic birds in the interior boreal forest region of Alaska. A dissertation presented to the faculty of the Graduate School University of Missouri-Columbia.
- Heinrichs, T.A., Kennedy, B.W., Langley D.E., Burrows, R.L., 2000, Methodology and estimates of scour at selected bridge sites in Alaska: U.S. Geological Survey Water-Resources Investigations Report 00-4151, 47 p. [Abstract and link to full report]
- Henry, G.H.R. and A. Gunn. 1991. Recovery of tundra vegetation after overgrazing by caribou in Arctic Canada. *Arctic* 44(1):38-42.
- Herlugson, C.J., J.D. McKendrick and J.A. Parnell. 1996. Gravel pad restoration on Alaska's North Slope. Paper presented at the International Conference on Health, Safety & Environment, New Orleans, 9-12 June 1996.
- Hernandez, H. 1973. Natural plant recolonization of surficial disturbances, Tuktoyaktuk Peninsula region, Northwest Territories. *Canadian Journal of Botany* 51:2177-2196.
- Hilliker, Benjamin L. 1991. Arctic terrestrial and fresh water crude oil spills: Fate and effects; restoration, rehabilitation, and revegetation; a bibliography. Prepared by ComRim Systems, Inc., Anchorage, Alaska.
- Hobbie, J. E., 1984. The ecology of tundra ponds of the Arctic coastal plain: a community profile. U. S. Fish and Wildlife Service, OBS-83/25. 52 pp.
- Hobbie, J.E. 1984. The ecology of tundra ponds of the arctic coastal plain: a community profile. *U.S. Fish Wildl. Serv., Rep.* FWS/OBS-83/25:1-52.
- Hogan, E.V., and Dorava, J.M., 1995, Overview of environmental and hydrogeologic conditions at seven Federal Aviation Administration sites in interior Alaska: U.S. Geological Survey Open-File Report 95-341, 50 p. (Nenana, Northway).
- Hultén, E. 1968. "Flora of Alaska and Neighboring Territories." Stanford University Press, Stanford, CA.
- Jacobs, L.L., M.T. Jorgenson and T.C. Cater. 1994. Wetland creation and revegetation on an overburden stockpile at Mine Site D, Kuparuk Oilfield, Alaska, 1993. Unpublished report sponsored by ARCO Alaska, Inc., Anchorage.
- Johnson, Larry. 1978. Biological restoration strategies in relation to nutrients at a subarctic site in Fairbanks, Alaska. Alaska Projects Office, U.S. Army Cold Regions Research and Engineering Laboratory, Fairbanks, Alaska.
- Jones, S. H., 1973. Small-stream flood investigations in Alaska. U.S. Geological Survey Basic-Data Report. 55 pp.
- Jones, S. H., 1983. Floods from small drainage basins in Alaska. U.S. Geological Survey Open-File Report 83-258, 60 pp.

Jones, S.H. and Fahl, C.B., 1994, Magnitude and frequency of floods in Alaska and conterminous basins of Canada: U.S. Geological Survey Water-Resources Investigations Report 93-4179, 122 p. + 2 plates. [Abstract] [Full Report 13.4 MB PDF file] [Plate 1 5.8 MB PDF file] [Plate 2 6.5 MB PDF file]

Jorgenson, M.T. 1987. Revegetation of the Lake State 1 exploratory well site, Prudhoe Bay Oilfield, Alaska, 1987. Alaska Biological Research, Inc. report to ARCO Alaska, Inc.

Jorgenson, M.T. and J.G. Kidd. 1994. Extent of vegetation impacts adjacent to eight drill sites in the Prudhoe Bay Oilfield, 1993, Final Report. Alaska Biological Research, Inc. report to ARCO Alaska, Inc. and CH2M Hill. May.

Jorgenson, M.T. and M.R. Joyce. 1994. Six strategies for rehabilitating land disturbed by oil development in arctic Alaska. *Arctic* 47(4):374-90.

Jorgenson, M.T., T.C. Cater, Michael D. Smith and Betty A. Anderson. 1995. Remote sensing of salinity and gravel impacts to tundra ecosystems using vegetation indicators at four drill sites in the Kuparuk Oilfield, 1994, Final Report. Alaska Biological Research, Inc. report to ARCO Alaska, Inc. October.

Joyce, M.R. 1987. Revegetation in the Arctic. Paper presented at the Fifth Symposium on Coastal and Ocean Management (Coastal Zone '87), Seattle, WA. May 26-29.

Kadlec, Robert H. and R.L. Knight. 1996. *Treatment Wetlands*. Lewis Publishers, Boca Raton, Florida.

Kane, D. L., J. N. Luthin, and G. S. Taylor, 1975. Heat and mass transfer in cold regions soils. University of Alaska, Institute of Water Resources, Report No. IWR 65. 50 pp.

Kershaw, G.P. and L.J. Kershaw. 1987. Successful plant colonizers on disturbances in tundra areas of northwestern Canada. *Arctic and Alpine Research* 19(4):451-460.

Kidd, J.G., T.C. Cater, L.J. Rossow, and M.T. Jorgenson. 1997. Land rehabilitation studies in the Kuparuk Oilfield, Alaska, 1996, Eleventh Annual Report. Alaska Biological Research, Inc. report to ARCO Alaska, Inc. and Kuparuk River Unit. June.

Komarkova, V. 1983. Recovery of plant communities and summer thaw at the 1949 Fish Creek Test Well 1, Arctic Alaska. Pages 645-650 in *Proceedings, Permafrost Fourth International Conference July 17-22, 1983, Fairbanks, AK*.

Lamke, R.D., 1978, Flood characteristics of Alaskan streams: U.S. Geological Survey Water-Resources Investigations 78-129, 61 p.

Lamke, R.D., 1984, Cost-effectiveness of the stream-gaging program in Alaska: U.S. Geological Survey Water-Resources Investigations Report 84-4096, 100 p.

Lamke, R.D., 1986, Alaska surface-water resources, in U.S. Geological Survey, National water summary 1985---Hydrologic events and surface-water resources: U.S. Geological Survey Water-Supply Paper 2300, p. 137-144

Lamke, R.D., 1991, Alaska floods and droughts, in U.S. Geological Survey, National water summary 1988-89---Hydrologic events and floods and droughts: U.S. Geological Survey Water-Supply Paper 2375, p. 171-180.

- Lamke, R.D., and Jones, S.H., 1980, Flood-prone area maps of three sites along the trans-Alaska pipeline, Alaska: U.S. Geological Survey Open-File Report 80-209, 14 p.
- Larson, Joseph S., P.R. Adamus and E.J. Clairain, Jr. 1993. Functional assessment of freshwater wetlands: a manual and training outline. Prepared by the World Wide Fund for Nature.
- Lawson, D.E. 1986. Response of permafrost terrain to disturbance: a synthesis of observations from northern Alaska, U.S.A. *Arct. Alpine Res.* 18:1-17.
- Lawson, D.E., J.Brown, K.R. Everett, A.W. Johnson, V. Komarkova, B.M. Murray, D.F. Murray and P.J. Webber. 1978. Tundra disturbances and recovery following the 1949 exploratory drilling, Fish Creek, Northern Alaska. Cold Regions Research and Engineering Laboratory (CRREL) Report 78-28. December.
- Lewellen, R. I., 1972. Studies on the fluvial environment, Arctic coastal plain province, northern Alaska. Robert I. Lewellen. 2 volumes.
- Lloyd, D. S., 1985. Turbidity in freshwater habitats of Alaska. Alaska Department of Fish and Game, Habitat Division, Report No. 85-1. 101 pp.
- Loeffler, R.M., and Childers, J.M., 1978, Channel erosion surveys along the TAPS route, Alaska, 1977: U.S. Geological Survey Open-File Report 78-611, 90 p.
- Mackay, J.R. 1970. Disturbance to the tundra and forest tundra environment of the western Arctic. *Canadian Geotechnical Journal* 7:420-432.
- Madison, R.J., 1981, Effects of placer mining on hydrologic systems in Alaska---Status of knowledge: U.S. Geological Survey Open-File Report 81-217, 25 p.
- Madison, R.J., McElhone, T.J., and Zenone, Chester, 1988, Alaska ground-water quality: U.S. Geological Survey Open-File Report 87-712, 8 p.
- Marble, Anne D. 1992. *A guide to wetland functional design*. Lewis Publishers, Boca Raton, Florida.
- March, R.S., 2000, Mass balance, meteorological, ice motion, surface altitude, runoff and ice thickness data at Gulkana Glacier, Alaska, 1995 balance year: U.S. Geological Survey Water-Resources Investigations Report 00-4074, 33 p. [Abstract and link to full report]
- Marcher, M.V., 1965, a summary of water-supply problems in Alaska, in Proceedings of the 15th Alaskan Science Conference, College: Science Alaska, p. 375-379.
- McCoy, G.A., 1983, Nutrient limitation in two Arctic lakes, Alaska: Canadian Journal of Fisheries and Aquatic Sciences, v. 40, 8 pg. 1195-1202.
- McKendrick, J.D. 1978. Effects of burning crude oil spilled onto six habitat types in Alaska. *Arctic* (31)3:277-295.
- McKendrick, J.D. 1986. Final cleanup at selected (1975-1981) wellsites, sampling and testing of waters and bottom muds in the reserve pits, and the recording of tundra plant responses on the National Petroleum Reserve in Alaska (NPRA), Vol. III. Recording of plant responses. Unpublished report sponsored by U.S. Geological Survey, Anchorage, AK.
- McKendrick, J.D. 1987. Plant succession on disturbed sites, North Slope, Alaska, U.S.A. *Arctic and Alpine Research* 19(4):554-565.

- McKendrick, J.D. 1990. Seed formation by *Arctophila fulva* in relation to temperature, Arctic Coastal Plain, Alaska.
- McKendrick, J.D. 1991. Arctic tundra rehabilitation: observations of progress and benefits to Alaska. *Agroborealis* (23)1: 29-40.
- McKendrick, J.D. 1991. Colonizing tundra plants to vegetate abandoned gravel pads in arctic Alaska. *Adv. Ecol.* 1:209-223.
- McKendrick, J.D. 1993a. *Arctophila fulva*. Transplanting *Arctophila fulva* to create emergent vegetation habitats in arctic Alaska. North Slope Habitat Series. Prepared for BP Exploration (Alaska) Inc. December, 1993.
- McKendrick, J.D. 1996a. Rehabilitating arctic tundra in Alaska. Presented to North American Water and Environment Congress, American Society of Civil Engineers.
- McKendrick, J.D. 1997a. Long-term tundra recovery in northern Alaska. Crawford, R.M. (ed.), (1997) In: *Disturbance and Recovery in Arctic lands: an Ecological Perspective* (in press) Kluwer Academic Publishers. pp. 503-518.
- McKendrick, J.D. 1997b. Memorandum to Ms. Judith Brendel, Alyeska Pipeline Service Company. September 11.
- McKendrick, J.D. 1997c. Recovery and rehabilitation of disturbed wetland sites. Presented at NPR-A symposium of Science, Traditional Knowledge, and the Resources of the Northeast Planning Area of the National Petroleum Reserve-Alaska, Anchorage, AK. April 16-18.
- McKendrick, J.D. and K.W. Holmes. 1989. Plant species on dredge tailings of interior and gravel pads of arctic Alaska. Pages 157-165, in S. Bandopadhyay and F.J. Skudrzyk, eds., "Mining in the Arctic." A.A. Balkema, Rotterdam.
- McKendrick, J.D. and W.W. Mitchell. 1978. Fertilizing and seeding of oil-damaged arctic tundra to effect vegetation recovery Prudhoe Bay, Alaska. *Arctic* (31)3: 296-304.
- McKendrick, J.D., G.O. Batzli, K.R. Everett and J.C. Swanson. 1980. Some effects of mammalian herbivores and fertilization on tundra soils and vegetation. *Arctic and Alpine Research* (12)4: 565-578.
- McKendrick, J.D., P.C. Scorup, W.E. Fiscus and G. Turner. 1992. Gravel vegetation experiments – Alaska North Slope. *Agroborealis* (24)1: 25-32.
- McKendrick, J.D., P.C. Scorup, W.E. Fiscus and G. Turner. 1992. Lessons from the Tunalik Test Wellsite No. 1 – National Petroleum Reserve in Alaska. *Agroborealis* (24)1: 33-40.
- McKendrick, J.D., P.C. Scorup, W.E. Fiscus, G. Turner, M.A. Fosberg and L.A. Sharp. 1993. Habitat and biological changes over time on exploratory wellsites in NPRA (National Petroleum Reserve in Alaska) 1984-1992. Pages 28-29, in "North Slope Third Annual Terrestrial Studies Workshop." Unpublished report sponsored by BP Exploration (Alaska), Inc., Anchorage.
- McKendrick, J.D., R.C. Wilkinson and R. Senner. 1997. Tundra plant succession and vascular plant species diversity. *Agroborealis* 29(1):28-30.
- McKendrick, J.D., V.J. Ott and G.A. Mitchell. 1978. Effects of nitrogen and phosphorus fertilization on carbohydrate and nutrient levels in *Dupontia fisheri* and *Arctagrostis latifolia*.

Pages 509-537, in L.L. Tieszen, ed., “Vegetation and Production Ecology of an Alaskan Arctic Tundra.” Springer-Verlag, New York.

Mellor, M., 1964. Properties of snow. U.S. Army Materiel Command, Cold Regions Research and Engineering Laboratory, Cold Regions Science and Engineering, Part III: Engineering, Sect. A: Snow Engineering. 105 pp.

Meyer, D. F., 1995, Flooding in the Middle Koyukuk River Basin, Alaska, August 1994: U.S. Geological Survey Water-Resources Investigations Report 95-4118, 8 p. + 2 plates. [Abstract]

Mitchell, W.W. 1970. Revegetation problems and progress. *Agroborealis* February 1970:18-19.

Mitchell, W.W. 1978. Development of plant materials for revegetation in Alaska. Presented at Proceedings: High Altitude Revegetation Workshop No. 3, Colorado State University, Fort Collins. 20 pp.

Mitchell, W.W. 1979. “Three Varieties of Native Alaskan Grasses for Revegetation Purposes,” Circ. 32. University of Alaska Agric. Exp. Stn., Fairbanks.

Mitchell, W.W. and J.D. McKendrick. 1972. Report of research progress on rehabilitation of disturbed ground in arctic Alaska. Unpublished report sponsored by University of Alaska, Institute of Agricultural Sciences, Palmer.

Mitchell, W.W. and J.D. McKendrick. 1975. Responses of arctic, boreal, and alpine biotypes in reciprocal transplants. *Biol. Pap. Univ. Alaska, Spec. Rep.* 2:92-111.

Mitchell, W.W., J.D. McKendrick, F.J. Wooding and M.A. Barzee. 1974. Agronomists on the banks of the Sagavanirktok. *Agroborealis* May 1974:33-35.

Nakanishi, A.S., and Dorava, J.M., 1994, Environmental overview and hydrogeologic conditions at Tanana, Alaska: U.S. Geological Survey Open-File Report 94-527, 16 p. + appendixes.

Nauman, J.W, and Kernodle, D.R., 1973, Field water quality information along proposed trans-Alaska pipeline corridor, September 1970 through September 1972: U.S. Geological Survey Open-File Report, 22 p.

Nauman, J.W, and Kernodle, D.R., 1977, Aquatic organisms from selected sites along the trans-Alaska pipeline corridor, September 1970 to September 1972, Supplement: U.S. Geological Survey Open-File Report 77634, 59 p.

Nauman, J.W., and Kernodle, D.R., 1975, The effect of a fuel oil spill on benthic invertebrates and water quality on the Alaskan Arctic Slope---Happy Valley Creek, near Sagwon: U.S. Geological Survey Journal of Research, v. 3, no. 4, p. 495-500.

Nauman, J.W., and Kernodle, D.R., 1975, Water-quality changes during a salmon run in an interior Alaskan stream: U.S. Geological Survey Journal of Research, v. 3, no. 1, p. 103105 (Paxson area).

Neiland, Bonita J. 1978. Rehabilitation of bare sites in interior Alaska. *Agroborealis* January 1978: 21-25.

Nelson, G.L., 1995, Overview of environmental and hydrogeologic conditions near Big Delta, Alaska: U.S. Geological Survey Open-File Report 95-180, 11 p.

- Nelson, G.L., and Munter, J.A., 1990, Ground water, in Ryan, W.L., and Crissman, R.D., eds. Cold Regions Hydrology and Hydraulics: American Society of Civil Engineers Monograph, p. 317-348.
- Newell, R.L. 1987. Revegetation in the Arctic. Paper presented at the Fifth Symposium on Coastal and Ocean Management (Coastal Zone '87), Seattle, WA. May 26-29.
- Nicholson, F.H. 1978. Permafrost modification by changing the natural energy budget. *in* Proceedings, Permafrost Third International Conference 1978, Edmonton Alberta, Canada.
- Norman, V.W., 1975, Scour at selected bridge sites, Alaska: U.S. Geological Survey Water-Resources Investigations 32-75, 160 p.
- Northern Technical Services, 1978. River and floodplain crossing design considerations and processes (2 volumes). Prepared for Fluor Engineers and Constructors, Inc. and Northwest Alaskan Pipeline Company.
- Novitzki, R.P., B.H. Rosen, L.S. McAllister, T.L. Ernst, B.E. Hutnley, and K. Dwire. 1994. EMAP—wetlands—research strategy for the assessment of wetland condition. Corvallis, Oregon. USEPA, Environmental Research Laboratory. 149pp.
- Ourso, Robert T., 2001, Effects of urbanization on benthic macroinvertebrate communities in
- Owensby, C.E. 1973. Modified step-point system for botanical composition and basal cover estimates. *Journal of Range Management* 26 (4):302-303.
- Parks, B., and R. J. Madison, 1985. Estimation of selected flow and water-quality characteristics of Alaskan streams. U. S. Geological Survey, Water-Resources Investigations Report 84-4247. 64 pp.
- Parks, Bruce, and Lamke, R.D., 1984, Estimating peak flow from channel widths in Alaska, in "Alaska's water---A critical resource," Proceedings, Alaska Section, American Water Resources Association: Institute of Water Resources, University of Alaska, Fairbanks, Report IWR-106, p. 107-122.
- Parks, Bruce, and Madison, R.J., 1985, Estimation of selected flow and water-quality characteristics of Alaskan streams: U.S. Geological Survey Water-Resources Investigations Report 84-4247, 64 p. [Full Report 6.3 MB PDF file]
- Parry, B.L. and G.A. Seaman. 1994. Restoration and enhancement of aquatic habitats in Alaska: case study reports, policy guidance, and recommendations. Technical Report 94-3. Alaska Department of Fish and Game, Habitat and Restoration Division, Anchorage.
- Patrick, L.D., 1984, is a water-use information program useful to Alaska? In "Alaska's water---A critical resource," Proceedings, Alaska Section, American Water Resources Association: Institute of Water Resources, University of Alaska, Fairbanks, Report IWR-106, p. 214-218.
- Patrick, L.D., Snyder, E.F., and Harle, M.L., 1990, Alaska water supply and use, in U.S. Geological Survey National water summary 1987---Hydrologic events and water supply and use: U.S. Geological Survey Water-Supply Paper 2350, p. 149-156.
- Pewe, T., 1982. Geologic hazards of the Fairbanks area, Alaska. Alaska Division of Geological and Geophysical Surveys, Special Report 15. 109 pp.

- Post, A. and L. R. Mayo, 1971. Glacier dammed lakes and outburst floods in Alaska. U.S. Geological Survey, Hydrologic Investigations Atlas HA-455. 4 sheets.
- Post, R.A. 1991. Restoring Alaska's wetlands. *National Wetlands Newsletter* July/August 1991. pp. 8-11.
- Post, Roger A. 1996. Functional profile of black spruce wetlands in Alaska. Prepared for U.S. Environmental Protection Agency. Alaska Department of Fish and Game Report. 170 pp.
- Racine, Charles H. and James C. Walters. 1991. Groundwater-discharge wetlands in the Tanana Flats, interior Alaska . US Army Corps of Engineers Cold Regions Research & Engineering Laboratory [Springfield, Va. Available from NTIS, 1991].
- Reynolds, J.F. and J.D. Tenhunen. 1996. Ecosystem response, resistance, resilience, and recovery in arctic landscapes: introduction. Pages 3-18, in J.F. Reynolds and J.D. Tenhunen, eds. "Landscape Function and Disturbance in Arctic Tundra." Springer-Verlag, New York.
- Richardson, C.J. et. al., 1978. Nutrient dynamics of northern wetland ecosystems. In Good et. al., eds. *Freshwater Wetlands Ecological Processes and Management Potential*. New York, New York.
- Richter, D.H., Lamarre, R.A., and Donaldson, D.E., 1973, Soda Creek Springs---Metamorphic water in the Eastern Alaska Range: U.S. Geological Survey Journal of Research, v. 1, no. 5, p. 523-528.
- Rickard, W.E. and J. Brown. 1974. Effects of off-road vehicles on the tundra landscape. *Environmental Conservation* 1:55-62.
- Rickard, Warren. 1972. Preliminary ecological evaluation of the effects of air cushion vehicle tests on the arctic tundra of northern Alaska. CRREL Special Report 182.
- Rickman, R.L., 1993, Alaska stream water quality, in U.S. Geological Survey, National water summary 1990-91---Hydrologic events and stream water quality: U.S. Geological Survey Water-Supply Paper 2400, p. 163-170.
- Rogers, H.B., C.A. Beyrouy, T.D Nichols, D.C. Wolf, and C.M Reynolds. 1996. Selection of cold tolerant plants for growth in soils contaminated with organics. *Journal of Soil Contamination* 5(2):171-186.
- Rovanssek, R.J., L.D. Hinzman and D.L. Kane. 1996. Hydrology of a tundra wetland complex on the Alaskan Arctic Coastal Plain, U.S.A. *Arctic and Alpine Research* 28(3):311-317.
- Scott, K. M., 1978. Effects of permafrost on stream channel behavior in Arctic Alaska. U.S. Geological Survey Professional Paper 1068. 19 pp.
- Scott, K.M., 1978, Effects of permafrost on stream channel behavior in Arctic Alaska: U.S. Geological Survey Professional Paper 1068, 19 p.
- Scott, K.M., 1979, Arctic stream processes---An annotated bibliography: U.S. Geological Survey Water-Supply Paper 2065, 78 p.
- Searby, H. W., 1968. Climate along a pipeline from the arctic to the Gulf of Alaska. U.S. Dept. of Commerce, Environmental Science Services Administration, Technical Report. 16 pp.
- Searby, H. W., 1968. Freeze-thaw cycle in the coastal Arctic of Alaska. U.S. Dept. of Commerce, Environmental Science Services Administration, Technical Report. 21 pp.

- Seibert, P. 1968. Importance of natural vegetation for the protection of the banks of streams, rivers, canals. In Nature and Environmental Series, Council of Europe.
- Senner, Robert G.B. 1989. Effects of petroleum operations in Alaskan wetlands. Prepared for ARCO Alaska inc. and BP Exploration (Alaska) Inc.
- Senner, Robert G.B. 1989. Executive Summary: Effects of petroleum operations in Alaskan wetlands. Prepared for Alaska Oil and Gas Association.
- Shaver, G.R. and F.S. Chapin III. 1986. Effect of fertilizer on production and biomass of tussock tundra, Alaska, U.S.A. *Arctic and Alpine Research* 18(3):261-268.
- Shaver, G.R., B.L. Gartner, F.S. Chapin III and A.E. Linkins. 1983. Revegetation of Arctic disturbed sites by native tundra plants. Pages 1133-1138 in Proceedings, Permafrost Fourth International Conference. July 17-2, 1983, Fairbanks, Alaska.
- Shuldene et. al., 1979. Ecological effects of highway fills on wetlands. American Association of State Highway and Transportation Officials. Final report #TRB/NCHRP/REP 218A.
- Simmons, C.L., K.R. Everett, D.A. Walker, A.E. Linkons, and P.J. Webber. 1983. Sensitivity of plant communities and soil flora to seawater spills, Prudhoe Bay, Alaska. CRREL Report 83-24. U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory. Hanover, New Hampshire.
- Sloan, C. E., S. Zenone, and L. R. Mayo, 1976. Icings along the Trans-Alaska Pipeline Route. U.S. Geological Survey Professional Paper 979. 31 pp.
- Sloan, C.E., 1987, Water resources of the North Slope, Alaska, in Irv Tailleir and Paul Weimer, eds. 1987, Alaskan North Slope Geology: Pacific Section, SEPM and Alaska Geological Society, v. 50, p. 233-252.
- Sloan, C.E., and Bredehoeft, J.D., 1972, some effects of a heated pipeline on ground water flow in Alaska: U.S. Geological Survey Open-File Report, 25 p.
- Sloan, C.E., Emery, P.A., and Zenone, Chester, 1985, Alaska ground-water resources, in U.S. Geological Survey, National water summary 1984, Hydrologic events, selected water-quality trends, and ground-water resources: U.S. Geological Survey Water-Supply Paper 2275, p. 129-132.
- Sloan, C.E., Zenone, Chester, and Mayo, L.R., 1976, Icings along the trans-Alaska pipeline route: U.S. Geological Survey Professional Paper 979, 31 p.
- Sloan, Charles, Trabant, Dennis, and Glude, William, 1979, Reconnaissance snow surveys of the National Petroleum Reserve in Alaska, April 1977 and April-May 1978: U.S. Geological Survey Water-Resources Investigations/Open-File Report 79-1342, 31 p.
- Smith, P.D.J. 1988. Cost analysis report of revegetating various sites with *Arctophila fulva*. Under subcontract to the University of Alaska Fairbanks *Arctophila* Revegetation Study. pp. 16-29.
- Snyder, E.F., 1992, The U.S. Geological Survey stream-gaging program in Alaska: U.S. Geological Survey Open-File Report 92-106, 1 p. [Fact Sheet].
- Snyder, E.F., 1993, Cold regions hydrology of Alaska: National Geographic Society, Research & Exploration, v. 9, p. 98-113.

- Snyder, E.F., 1997, Water-resources activities of the U.S. Geological Survey in Alaska, 1997: U.S. Geological Survey Fact Sheet FS-028-97, 4 p.
- Still, P. J., 1980. Index of streamflow and water-quality records to September 30, 1978, Arctic Slope, Alaska. U.S. Geological Survey Open-File Report 80-554, 18 pp.
- Still, P.J., and Brunett, J.O., 1987, Ground-water levels in Alaska, water year 1984: U.S. Geological Survey Open-File Report 87-230, 308 p.
- Strandberg, B. 1997. Vegetation recovery following anthropogenic disturbances in Greenland. Pages 381-390, in R.M.M. Crawford, ed., "Disturbance and Recovery in Arctic Lands." Kluwer Academic Publishers, Dordrecht, The Netherlands.
- Troy, D.M. 1991. Bird use of disturbed tundra at Prudhoe Bay, Alaska: bird and nest abundance along the abandoned peat roads, 1988-1989. Unpublished report sponsored by BP Exploration (Alaska), Inc., Anchorage.
- Truett, J.C. and K. Kertell. 1992. Tundra disturbance and ecosystem production: implications for impact assessment. *Environ. Manag.* (N.Y.) 16:485-494.
- Truett, Joe C. and Stephen R. Johnson. 2000. *The Natural History of an Arctic Oil Field: Development and the Biota*. Academic Press, San Diego, California.
- U.S. Army Corps of Engineers. 1987. Wetlands delineation manual. Environmental Laboratory. Department of the Army, Waterways Experiment Station, Vicksburg, MS.
- U.S. Department of the Interior/U.S. Army Corps of Engineers. 1988. Final environmental impact statement for the proposed Trans-Alaska Gas System. Prepared by the Bureau of Land Management and the U.S. Army Corps of Engineers, Alaska District, Anchorage.
- U.S. Geological Survey, 1969, Water resources of the Arctic Slope Region, Alaska---Preliminary report: U.S. Geological Survey Open-File Report, 31 p.
- Van Cleve, K. 1975. Recovery of disturbed tundra and taiga surfaces in Alaska. International Symposium on Recovery of Damaged Ecosystems. Virginia Polytechnic Institute. Blacksburg, VA. 23-25 March 1975.
- Viereck, L.A., C.T. Dyrness, A.R. Batten and K.J. Wenzlick. 1992. The Alaska vegetation classification system. Gen. Tech. Rep. PNW-GTR-286. Portland, Oregon: Department of Agriculture, Forest Service, Pacific Northwest Research Station. 278 p.
- Walker, D.A. 1983. A hierarchical tundra vegetation classification especially designed for mapping in northern Alaska. Pages 1332-1337 in Proceedings, Permafrost Fourth International Conference July 17-22, 1983, Fairbanks, AK.
- Walker, D.A. 1985. Vegetation and environmental gradients of the Prudhoe Bay region, Alaska. *U.S. Army Cold Reg. Res. Eng. Lab., Rep.* 85-14.
- Walker, D.A. 1997. Arctic Alaskan vegetation disturbance and recovery. *Disturbance and Recovery in Arctic Lands*, R.M.M. Crawford (ed.), 1997, Netherlands. pp. 457-79.
- Walker, D.A. and K.R. Everett. 1987. Road dust and its environmental impact on Alaskan taiga and tundra. *Arctic and Alpine Research* 19(4): 479-489.
- Walker, D.A. and K.R. Everett. 1991. Loess ecosystems of northern Alaska: regional gradient and toposequence at Prudhoe Bay. *Ecological Monographs* 61(4):437-464.

- Walker, D.A. and M.D. Walker. 1991. History and pattern of disturbance in Alaskan arctic terrestrial ecosystems: a hierarchical approach to analyzing landscape change. *J. Appl. Ecol.* 28:244-276.
- Walker, D.A., D. Cate, J. Brown and C. Racine. 1987b. Disturbance and recovery of arctic Alaskan tundra terrain. *U.S. Army Cold Reg. Res. Eng. Lab., Rep.* 87-11:63.
- Walker, D.A., E.F. Binnian, N.D. Lederer, E.A. Nordstrand, M.D. Walker and P.J. Webber. 1986. "Cumulative Landscape Impacts in the Prudhoe Bay Oil Field, 1949-1983." *U.S. Fish and Wildl. Serv., Habitat Resour. Sect.*, Anchorage, AK.
- Walker, D.A., K.R. Everett, P.J. Webber and J. Brown. 1980. Geobotanical atlas of the Prudhoe Bay region, Alaska. U.S. Army Corps of Engineers, Cold Region Research Engineering Laboratory, Hanover, NH. CRREL Report 80-14.
- Walker, D.A., P.J. Webber, E.F. Binnian, K.R. Everett, H.D. Lederer, E.A. Nordstrand and M.D. Walker. 1987a. Cumulative impacts of oil fields on northern Alaska landscapes. *Science* 238:757-761.
- Walker, K.M., York, James, Murphy, Dennis, and Sloan, C.E., 1986, Digital data base of lakes on the North Slope, Alaska: U.S. Geological Survey Water-Resources Investigations Report 86-4143, 13 p.
- Walker, M.D., D.A. Walker and K.R. Everett. 1989. Wetland soils and vegetation, Arctic Foothills, Alaska. National Ecology Research Center, U.S. Fish and Wildlife Service Biological Report 89(7). June. 89 pp.
- Waller, R.M., 1961, Summary of ground water conditions in Alaska as they affect private water supplies: U.S. Geological Survey and Alaska Department of Health Hydrological Data Report 11, 2 p.
- Waller, R.M., and Tolen, D.A., 1962, Data on wells and springs along the Richardson Highway, Alaska: U.S. Geological Survey and Alaska Department of Health Hydrological Data Report 16, 32 p.
- Wang, Bronwen, 1999, Influence of Hue Shale weathering on water chemistry in Hue Creek, Arctic National Wildlife Refuge, Alaska, in The oil and gas resource potential of the 1002 Area, Arctic National Wildlife Refuge, Alaska, by ANWR Assessment Team: U.S. Geological Survey Open-File Report 98-34, CD-ROM.
- Webber, P.J. and D.A. Walker. 1975. Vegetation and landscape analysis at Prudhoe Bay, Alaska: A vegetation map of the tundra biome study area. Ecological Investigations of the Tundra Biome in the Prudhoe Bay Region, Alaska, Jerry Brown (ed.), October 1975. pp. 81-89.
- Webber, P.J. and J.D. Ives. 1978. Recommendations concerning the damage and recovery of tundra vegetation. *Environmental Conservation* 5(3):171-182.
- Wilcox, D.E., 1980, Geohydrology of the Delta Clearwater area, Alaska: U.S. Geological Survey Water-Resources Investigations 80-92, 26 p.
- Williams, G. P., 1973. The effect of lake and river ice on snowmelt runoff. National Research Council of Canada, Division of Building Research, Technical Paper No. 384. 66 pp.

Williams, J. R., 1970. Ground water in permafrost regions of Alaska. U.S. Geological Survey Professional Paper 696. 83 pp.

Williams, P.J. and M.W. Smith. 1989. The Frozen Earth: Fundamentals of Geocryology. Cambridge University Press.

Wright, Stoney J., W.L. Campbell, N.J. Moore, C.I. Wright and D. Sheaver. 1995. Annual Report: 1994. Alaska Plant Materials Center, Alaska Department of Natural Resources.

Wright, Stoney. 1994. Beach wildrye: planting guide for Alaska. Alaska Plant Materials Center, Alaska Department of Natural Resources.

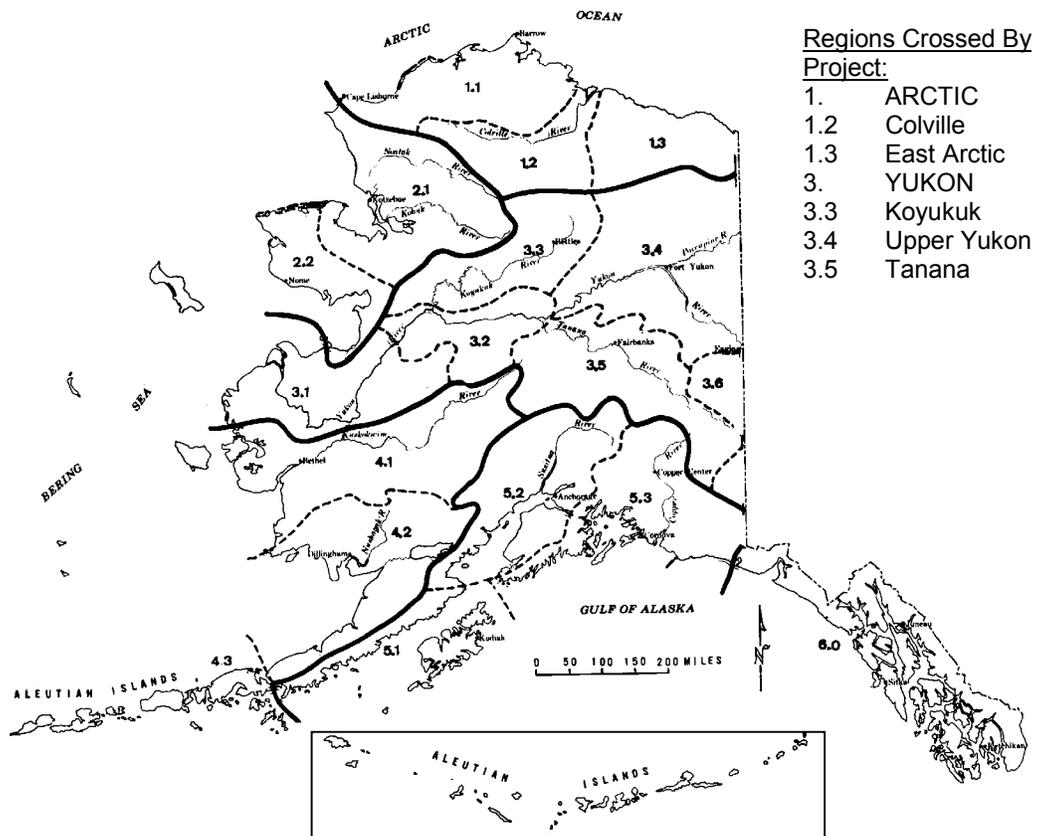
Wright, Stoney. 1997. Girdwood to Ingram Creek restoration project: final report 1996. Prepared for Chugach Electric Association, Inc. Alaska Plant Materials Center, Alaska Department of Natural Resources.

Zenone, Chester, and Anderson, G.S., 1978, Summary appraisal of the Nation's ground-water resources---Alaska: U.S. Geological Survey Professional Paper 813-P, 28 p. (reprinted 1981).

## 8.6 ATTACHMENTS

Attachment A – Selected Water Resource Baseline Information

**ATTACHMENT 8.A**  
**SELECTED WATER RESOURCES BASELINE INFORMATION**



Regions Crossed By Project:

- 1. ARCTIC
- 1.2 Colville
- 1.3 East Arctic
- 3. YUKON
- 3.3 Koyukuk
- 3.4 Upper Yukon
- 3.5 Tanana

**Figure 8.A.1**

**Hydrologic Subregions and Subareas in Alaska (Balding 1976).**





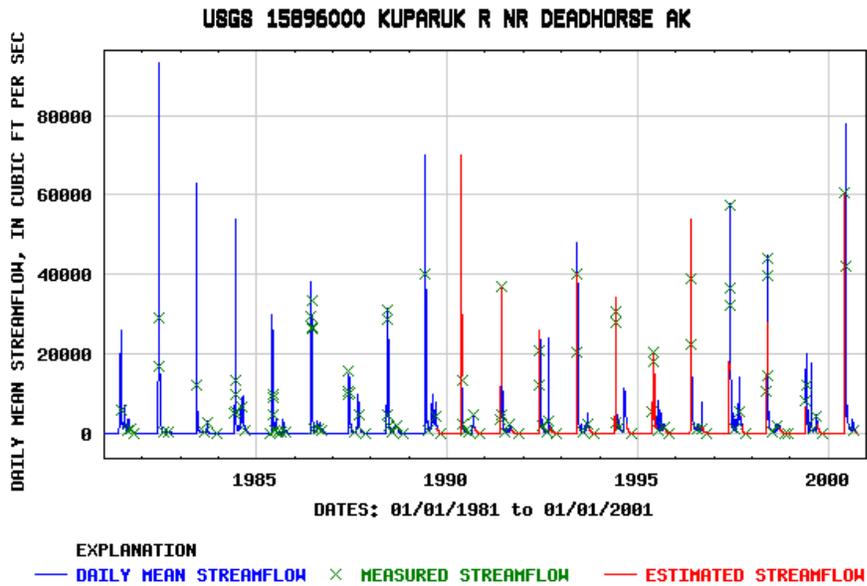
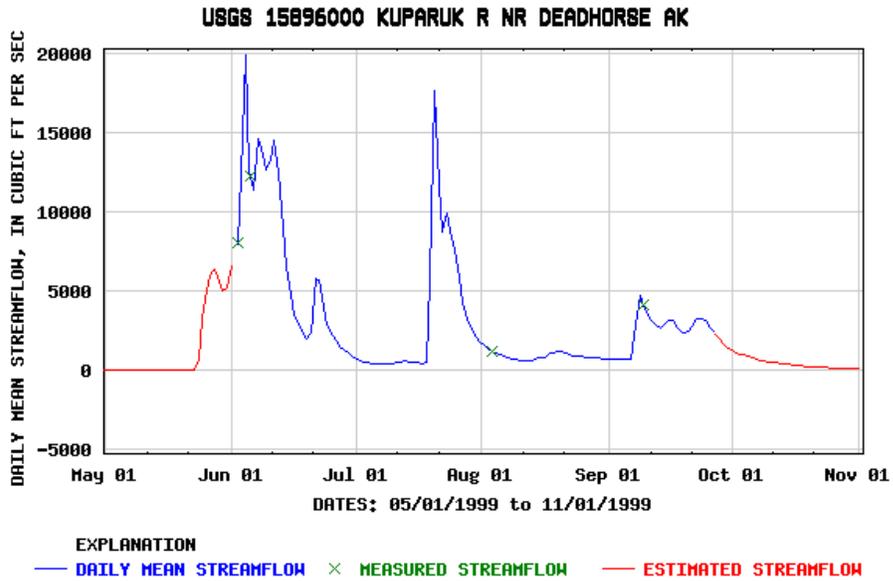


Figure 8.A.4

Hydrograph for Kuparuk River near Deadhorse on the North Slope  
(<http://waterdata.usgs.gov/ak/nwis/current/?type=flow>).

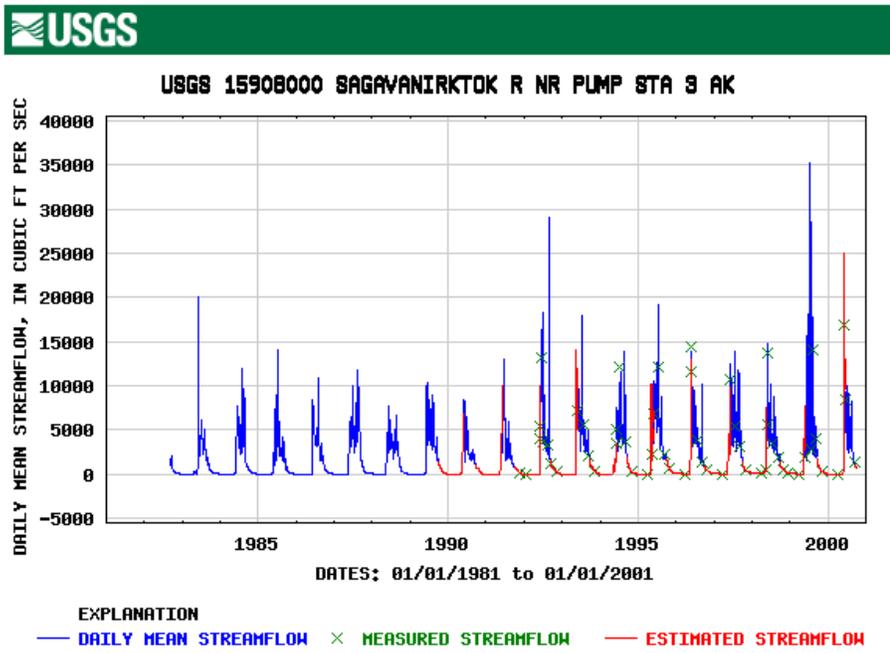
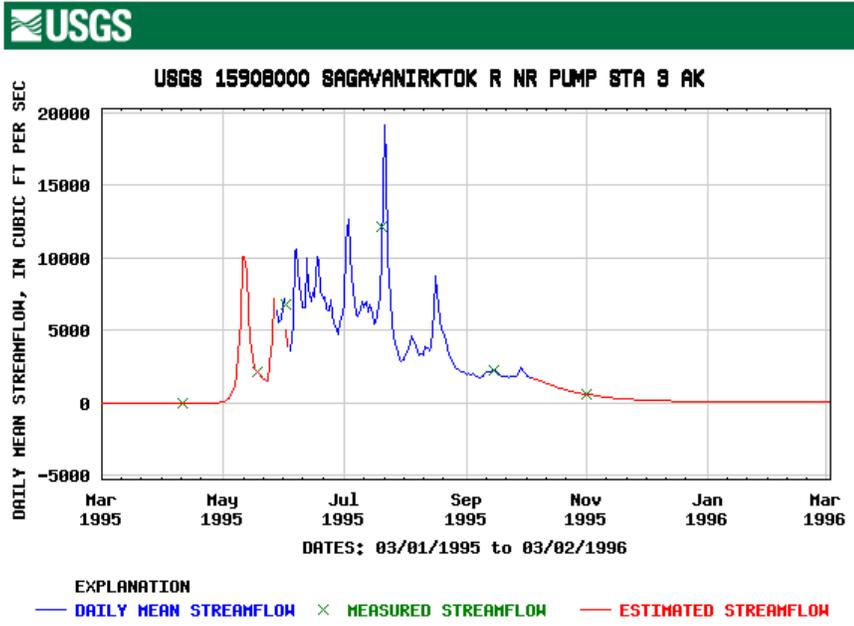
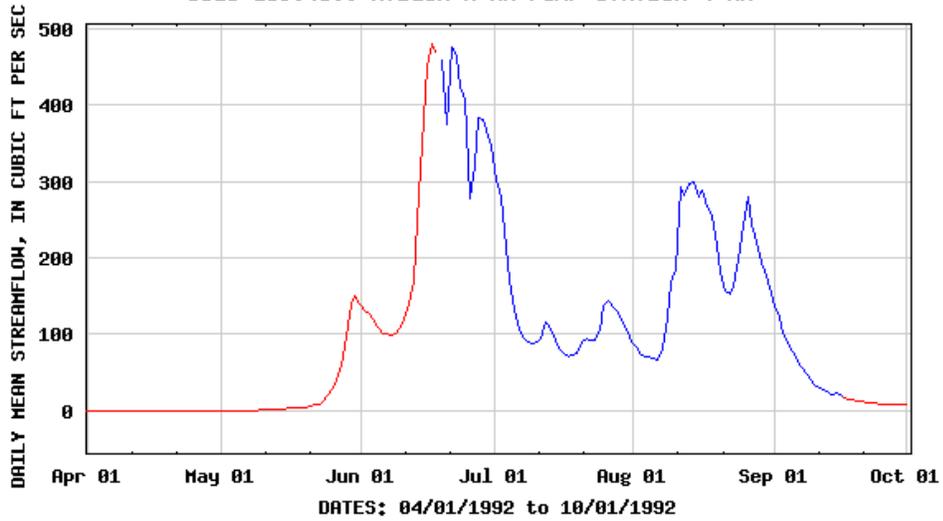


Figure 8.A.5

Hydrograph for Sagavanirktok River near TAPS Pump Station #3 on the North Slope (<http://waterdata.usgs.gov/ak/nwis/current/?type=flow>).



USGS 15904800 ATIGUN R NR PUMP STATION 4 AK



EXPLANATION  
— DAILY MEAN STREAMFLOW — ESTIMATED STREAMFLOW



USGS 15904800 ATIGUN R NR PUMP STATION 4 AK



EXPLANATION  
— DAILY MEAN STREAMFLOW — ESTIMATED STREAMFLOW

Figure 8.A.6

Hydrograph for Atigun River near TAPS Pump Station #4 in the Brooks Range.

(<http://waterdata.usgs.gov/ak/nwis/current/?type=flow>).

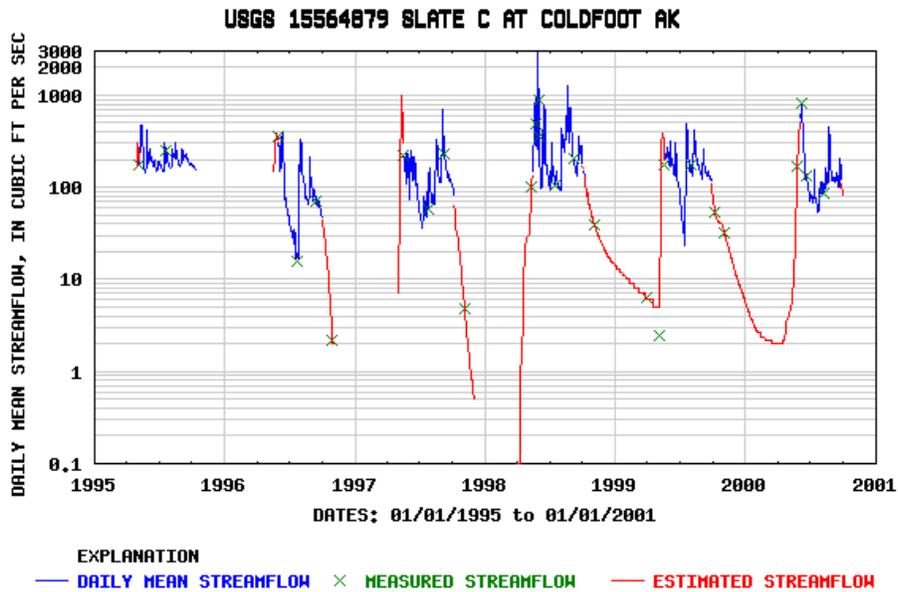
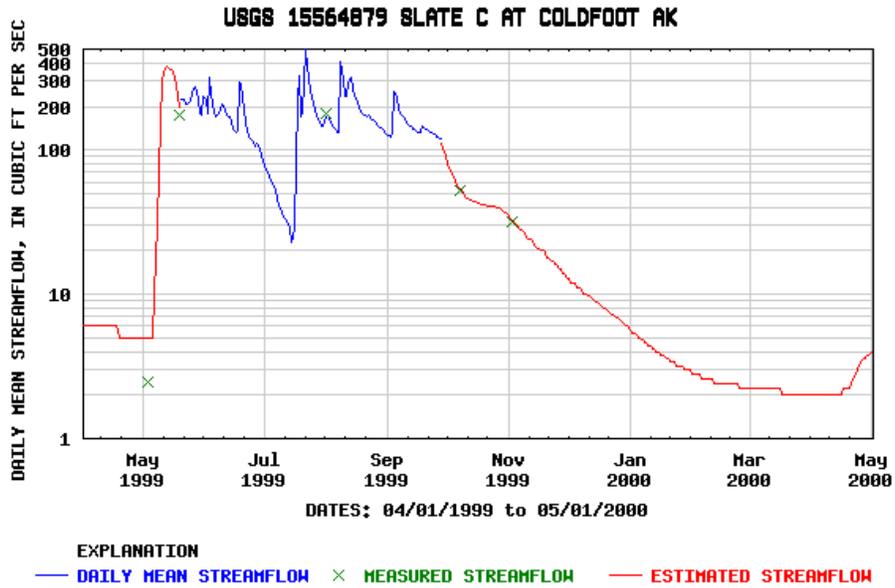
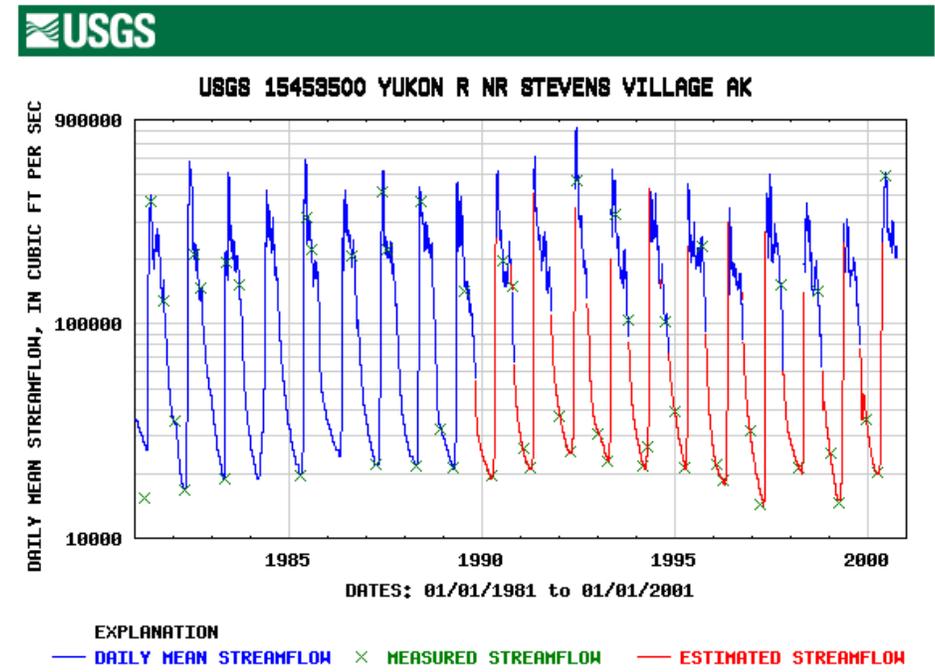
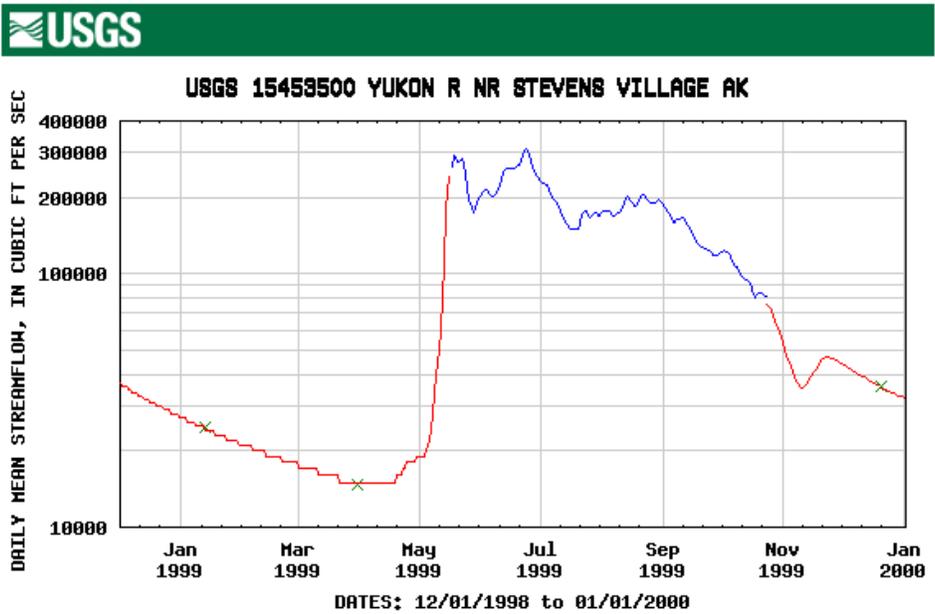


Figure 8.A.7

Hydrograph for Slate Creek near Coldfoot

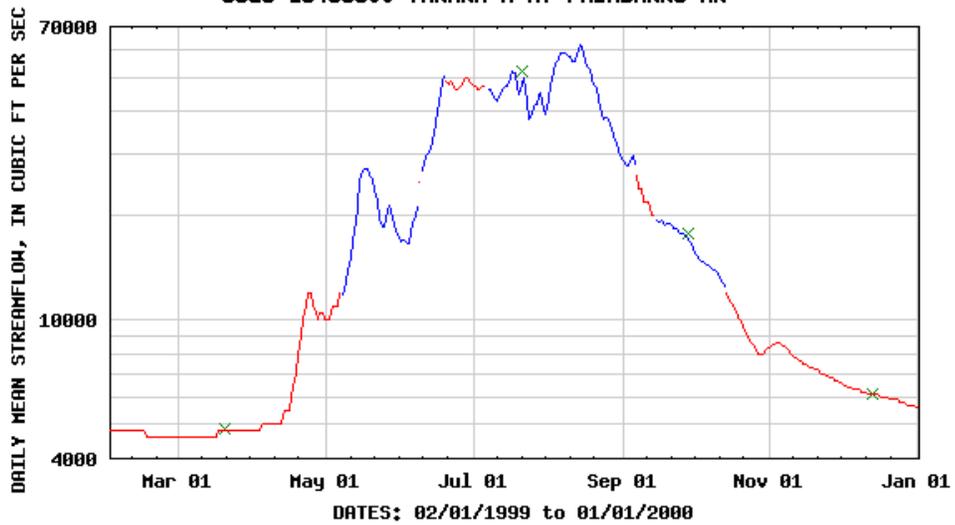
(<http://waterdata.usgs.gov/ak/nwis/current/?type=flow>).



**Figure 8.A.8**  
**Hydrographs for Yukon River near Stevens Village**  
 (<http://waterdata.usgs.gov/ak/nwis/current/?type=flow>).



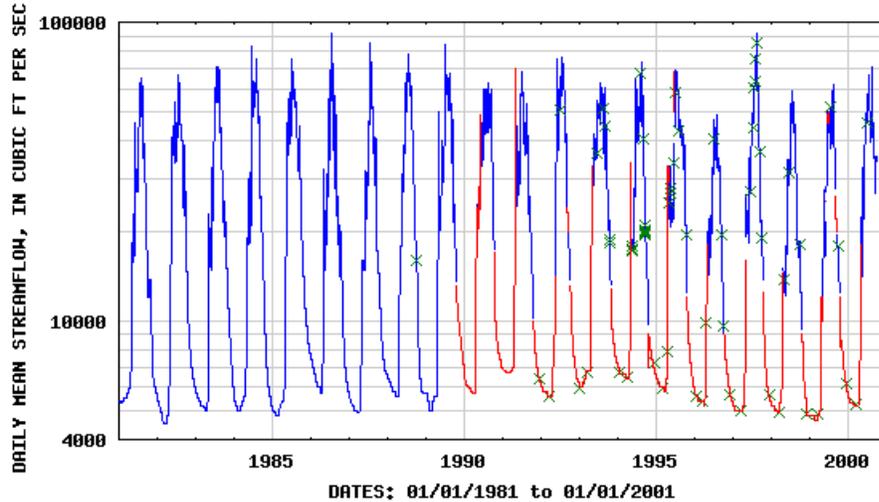
### USGS 15485500 TANANA R AT FAIRBANKS AK



EXPLANATION  
— DAILY MEAN STREAMFLOW × MEASURED STREAMFLOW — ESTIMATED STREAMFLOW



### USGS 15485500 TANANA R AT FAIRBANKS AK



EXPLANATION  
— DAILY MEAN STREAMFLOW × MEASURED STREAMFLOW — ESTIMATED STREAMFLOW

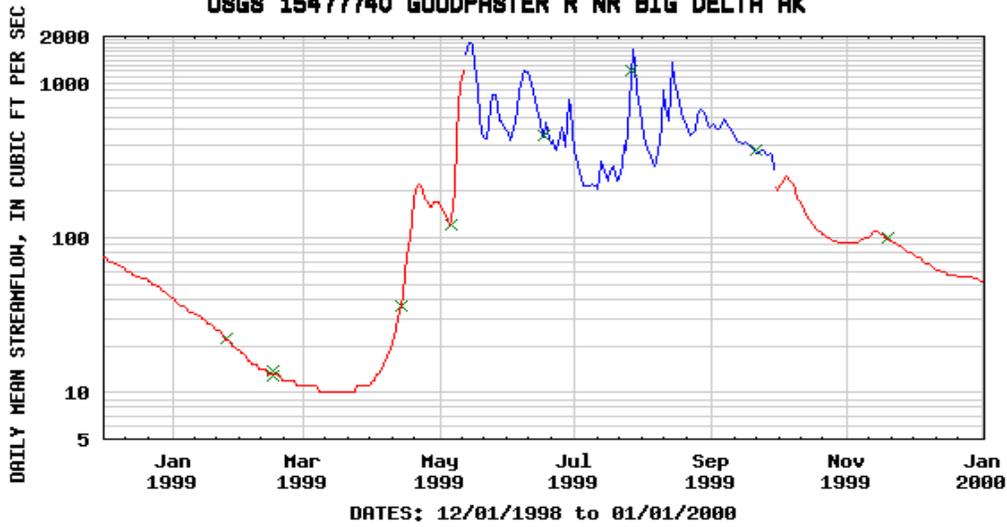
Figure 8.A.9

Hydrographs for Tanana River near Fairbanks

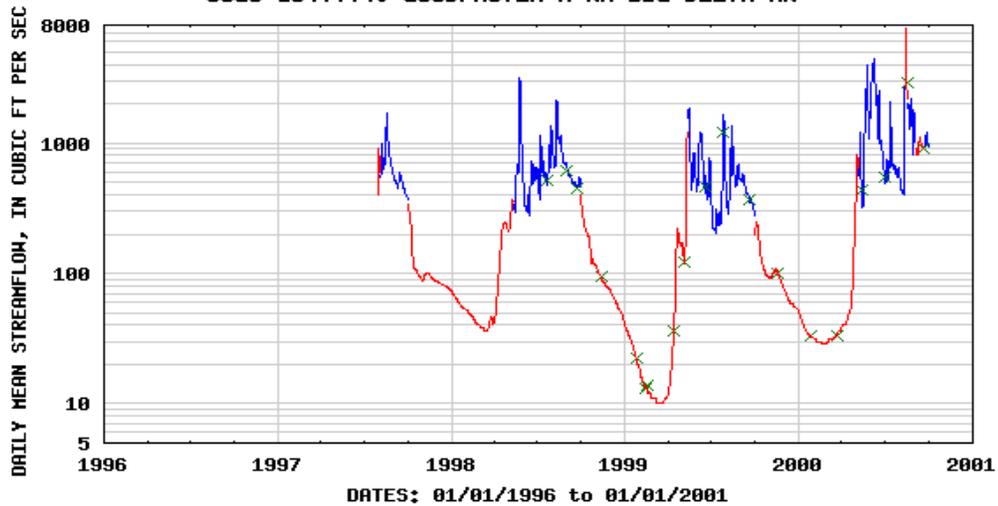
(<http://waterdata.usgs.gov/ak/nwis/current/?type=flow>).



USGS 15477740 GOODPASTER R NR BIG DELTA AK



USGS 15477740 GOODPASTER R NR BIG DELTA AK



EXPLANATION  
— DAILY MEAN STREAMFLOW × MEASURED STREAMFLOW — ESTIMATED STREAMFLOW

Figure 8.A.10

Hydrograph for Goodpaster River near Big Delta

(<http://waterdata.usgs.gov/ak/nwis/current/?type=flow>)..

## PRUDHOE BAY, ALASKA (507780)

### Period of Record Monthly Climate Summary

Period of Record : 4/ 1/1986 to 6/30/1999

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	-11.9	-10.1	-5.2	10.1	28.8	45.2	55.4	51.0	38.3	21.0	0.9	-6.6	18.1
Average Min. Temperature (F)	-24.0	-24.3	20.3	-4.8	19.0	32.7	39.7	37.5	28.9	9.7	-11.0	-19.2	5.3
Average Total Precipitation (in.)	0.20	0.17	0.14	0.08	0.09	0.39	0.68	1.14	0.61	0.38	0.18	0.20	4.26
Average Total SnowFall (in.)	2.8	2.4	2.7	1.7	1.4	1.0	0.0	0.5	3.5	9.3	4.3	3.5	33.1
Average Snow Depth (in.)	4	4	4	3	1	0	0	0	0	3	3	4	2

Percent of possible observations for period of record.

Max. Temp.: 99.6% Min. Temp.: 99.6% Precipitation: 99.9% Snowfall: 100% Snow

Depth: 99.7%

## BETTLES FAA AIRPORT, ALASKA (500761)

### Period of Record Monthly Climate Summary

Period of Record : 5/ 1/1951 to 12/31/2000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	-4.7	0.7	14.7	32.4	53.1	68.0	69.4	62.2	48.5	25.0	5.6	-2.0	31.1
Average Min. Temperature (F)	-20.5	-17.6	-8.6	10.1	33.5	46.9	49.0	43.6	32.2	11.9	-8.4	17.0	12.9
Average Total Precipitation (in.)	0.81	0.68	0.66	0.52	0.68	1.36	1.98	2.58	1.79	1.11	0.89	0.86	13.92
Average Total SnowFall (in.)	12.6	9.8	10.0	6.7	1.1	0.0	0.0	0.1	2.1	11.9	13.4	14.8	82.4
Average Snow Depth (in.)	26	29	31	26	4	0	0	0	0	4	12	20	13

Percent of possible observations for period of record.

Max. Temp.: 98.9% Min. Temp.: 98.8% Precipitation: 98.8% Snowfall: 98.9% Snow

Depth: 98.9%

Table 8.A.1

Climate Records for Prudhoe Bay and Bettles, Alaska.

(<http://www.wrcc.dri.edu/summary/climsmak.html>)

# FAIRBANKS WSO AIRPORT, ALASKA (502968)

## Period of Record Monthly Climate Summary

Period of Record : 9/ 1/1949 to 12/31/2000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	-1.5	7.5	24.1	42.3	59.8	70.8	72.4	66.2	54.5	31.9	11.5	1.2	36.7
Average Min. Temperature (F)	-19.3	-14.7	-2.3	20.3	37.5	49.0	51.8	46.6	35.5	17.1	-5.0	-15.7	16.7
Average Total Precipitation (in.)	0.59	0.42	0.36	0.23	0.57	1.36	1.78	1.86	1.06	0.80	0.69	0.73	10.46
Average Total SnowFall (in.)	10.8	8.5	6.2	2.9	0.7	0.0	0.0	0.0	1.5	10.9	13.4	12.9	67.8
Average Snow Depth (in.)	18	22	20	10	0	0	0	0	0	2	8	13	8

Percent of possible observations for period of record.  
 Max. Temp.: 99.8% Min. Temp.: 99.8% Precipitation: 99.9% Snowfall: 99.9% Snow Depth: 99.8%

# BIG DELTA FAA/AMOS AP, ALASKA (500770)

## Period of Record Monthly Climate Summary

Period of Record : 2/ 1/1937 to 12/31/2000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	3.1	11.7	23.8	40.7	56.9	67.0	69.5	64.4	52.5	31.6	13.8	5.0	36.7
Average Min. Temperature (F)	-11.4	-5.6	1.9	20.4	36.9	47.2	50.5	45.7	35.5	18.1	-0.2	-9.3	19.1
Average Total Precipitation (in.)	0.34	0.33	0.26	0.25	0.88	2.32	2.63	2.01	1.09	0.64	0.48	0.37	11.62
Average Total SnowFall (in.)	5.6	5.2	4.3	2.8	0.6	0.0	0.0	0.0	1.6	9.2	8.5	5.8	43.8
Average Snow Depth (in.)	8	10	9	4	0	0	0	0	0	2	5	6	4

Percent of possible observations for period of record.  
 Max. Temp.: 91.9% Min. Temp.: 92.5% Precipitation: 91.9% Snowfall: 86.5% Snow Depth: 87.9%

**Table 8.A.2**

**Climate Records for Fairbanks and Big Delta, Alaska.**

(<http://www.wrcc.dri.edu/summary/climsmak.html>)

# TOK, ALASKA (509313)

## Period of Record Monthly Climate Summary

Period of Record : 6/11/1954 to 12/31/2000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	-7.4	7.1	25.4	43.9	60.0	70.4	72.9	68.1	54.4	31.1	8.4	-4.0	35.8
Average Min. Temperature (F)	-25.8	-16.9	-5.9	15.6	29.3	39.4	43.2	38.6	29.0	12.1	-10.5	-22.2	10.5
Average Total Precipitation (in.)	0.31	0.28	0.15	0.17	0.58	2.16	1.94	1.30	0.74	0.55	0.49	0.40	9.08
Average Total SnowFall (in.)	4.4	3.5	2.1	2.0	0.7	0.0	0.0	0.3	1.6	7.1	6.7	5.1	33.4
Average Snow Depth (in.)	14	16	15	9	0	0	0	0	0	3	8	11	6

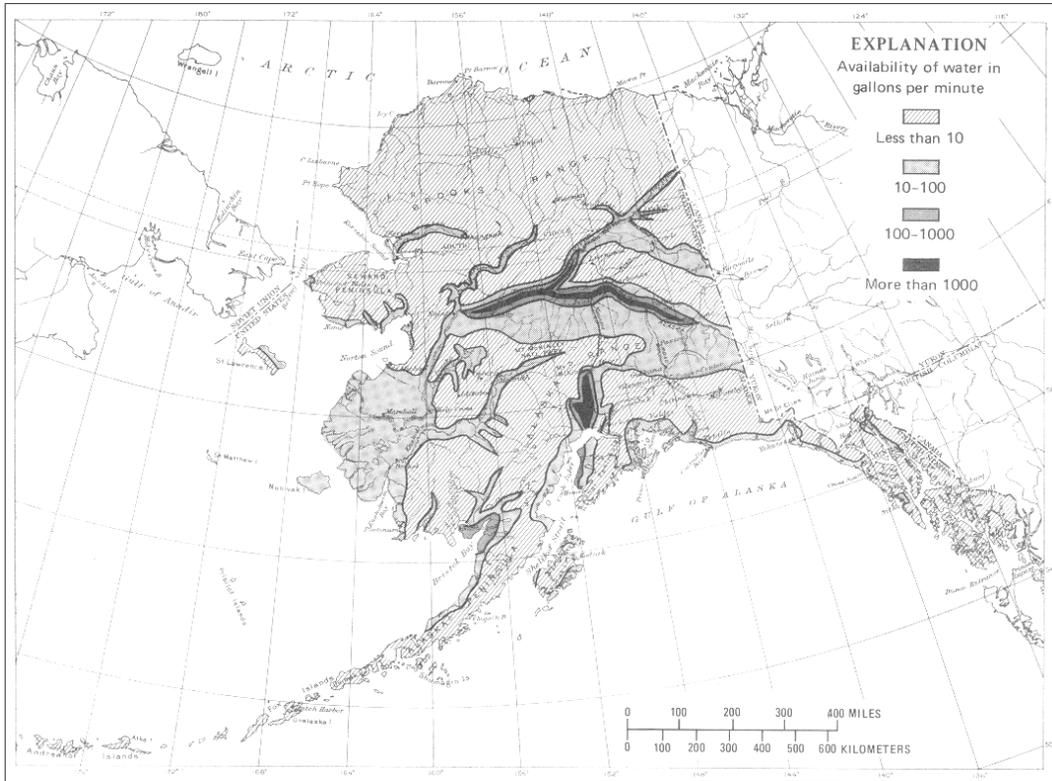
Percent of possible observations for period of record.

Max. Temp.: 86.6% Min. Temp.: 86.3% Precipitation: 74.4% Snowfall: 75.9% Snow Depth: 70.1%

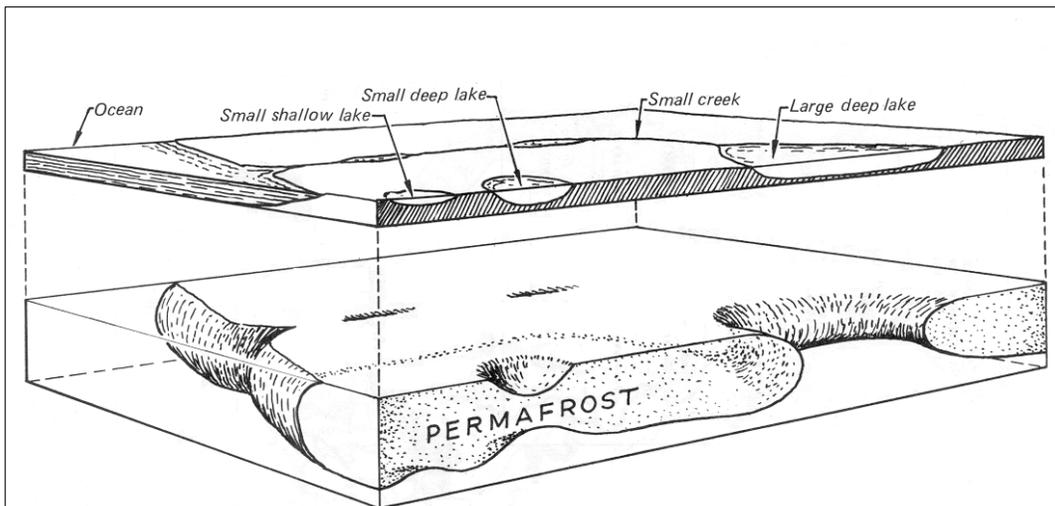
**Table 8.A.3**

### Climate Records for Tok, Alaska.

(<http://www.wrcc.dri.edu/summary/climsmak.html>)



**Figure 8.A.11**  
**Generalized Map of Groundwater Availability (Zenone and Anderson 1978).**



**Figure 8.A.12**  
**Conceptual Representation of Continuous Permafrost Areas.**



a. Sheep Creek on Richardson Highway Prior to Flooding.



b. Sheep Creek in September 1945 Following Flooding.

**Figure 8.A.13**  
**Example of Glacier Outburst Flooding Effects (Post and Mayo 1971).**